This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

47. 408?

47. 408?

BODY AND SOUL;

OR,

LIFE, MIND, AND MATTER,

CONSIDERED AS TO

THEIR PECULIAR NATURE, AND COMBINED CONDITION IN LIVING THINGS;

WITH A VIEW TO RENDER

THE PHYSIOLOGY OF LIFE AND MIND MORE EASILY UNDERSTOOD BY THE GENERAL READER.

Illustrated by Drawings.

BY

GEORGE REDFORD,

MEMBER OF THE ROYAL COLLEGE OF SURGEONS, LONDON,

&c. &c. &c.

LONDON:

JOHN CHURCHILL, PRINCES STREET, SOHO.

MDCCCXLVII.

DENNETT, PRINTER, 121, FLEET STREET, LONDON.

PREFACE.

In submitting this book to the public, its imperfections and shortcomings rise most prominently before my mind; but as to point these out to the reader at the outset would be a very unsatisfactory subject to him, and no excuse on my part for their existence, I shall leave them to his tender mercies as they occur to him, and endeavour to propitiate him by saying, that the work was commenced some years ago for the sake of settling my own ideas upon the matters it refers to: at that time I had no intention of publishing, but meeting with so many persons since then, some educated in the same profession as myself, who had thought much upon the subjects it concerns, and, like myself, found in them much to perplex and astonish as well as to interest; and others who, though they have not been obliged to study such subjects, have often found their minds occupied in attempting to understand and explain the phenomena treated of in this volume; it occurred to me, that, perhaps, the sort of synopsis (for it has little more pretension) now offered might prove useful, as well as interesting, to those who like to pry into the mysteries of nature.

I lament that so little, in explanation of these mysteries, can be said; still it is generally useful to know what there is that we do not know, and how far explanation may be carried, especially that we may avoid that too common disposition to throw a veil of mystery, and sort of almighty incomprehensibility, over subjects which are really, perhaps, capable of reduction to the effect of general laws, without the possibility of detracting from that reverence which belongs to the mysterious omnipotence of the Deity.

An apology is due to those who profess metaphysics for the very scanty and general manner in which the mental phenomena are treated of; but I wished to avoid metaphysics as much as possible, and to deal more with tangible things, without however the least disrespect to such admirable models of composition and thought as the works of Stewart and others. I could have wished, however, to have given a more extended view of the opinions of the ancients as regards life and mind; but other engagements have prevented my being able to give sufficient time to make myself well acquainted with that subject, even did the intention of the work admit it. I would therefore refer the reader to the extensive work, by Carl Von Ritter, ("Manual of Philosophy," translated,) to Cudworth's "Intellectual System," Harris's "Philosophical Arrangements," and other works.

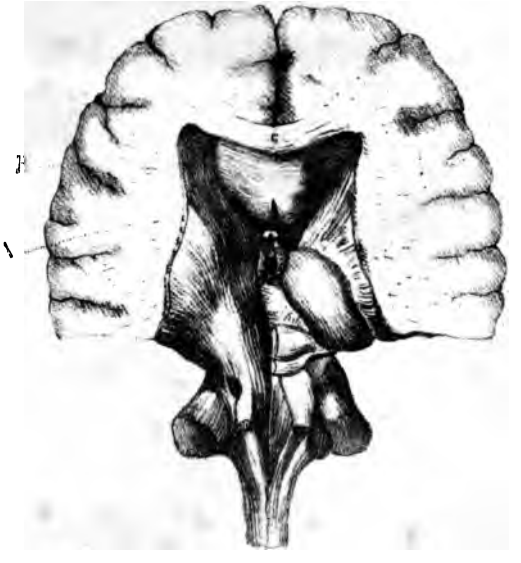
By the general reader too I fear the little anatomy which appeared almost indispensable, will be thought prosy and out of place, but it seemed necessary to say thus much as to certain parts of the brain, if it were only to show that they are easily distinguished, and that the organ is above all others most curiously and delicately formed.

It would be rather absurd to make pretensions to originality in a work like this, founded so much upon general views and upon what has been done by others, but in the treatment of the subject of "mind," the reader will find opinions expressed, and terms made use of in reference to ideas and consciousness, which would appear to have been taken from Müller without acknowledgment; I therefore explain, that this part was written essentially as it now stands, before the part of Dr. M.'s physiology upon the subject was published.

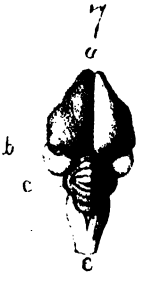
In conclusion, I must beg it will be remembered that this book is intended for the general reader, for those who are sometimes mystified or shallowly enlightened by the confident explanations of materialists, over-chemical chemists, phrenologists, and mesmerists, and not for finished students of anatomy and physiology.

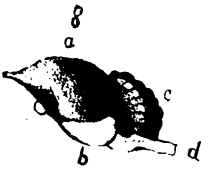
Golden Square,
Jan. 1847.

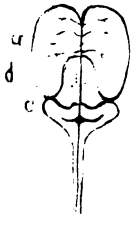
CONTENTS.

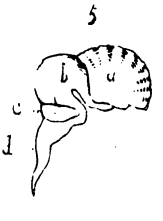

c
B
1

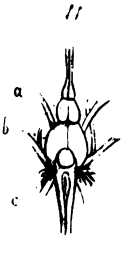

4
a
e

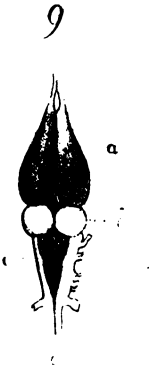

7
a
b
c
c


8
a
c
b
d


6
a
d
c


5
b
a
c
d

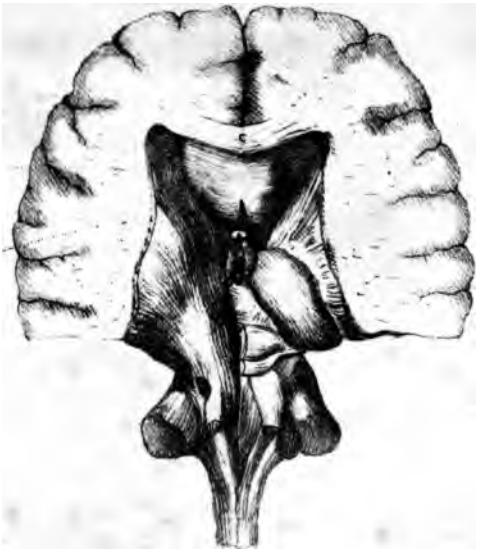

11
a
b
c


9
a
c

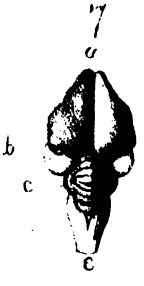

12
c
b
a
d
e
f

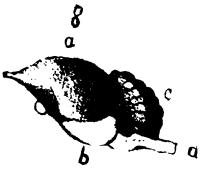

10
b
a
c
f

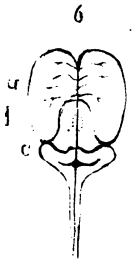
fig 3

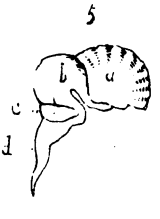

c
P
1

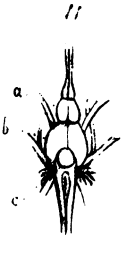

64
c
a
e


7
a
b
c
c


8
a
c
b
a


6
a
b
c


5
b
a
c
d


11
a
b
c


9
a
c


12
c
b
a
d
e
f

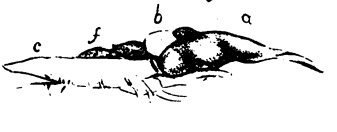

10
b
a
c
f

fig 3

BODY AND SOUL.

PART I.—LIFE.

INTRODUCTION.

General comparative View of animate and inanimate Bodies, exhibiting differences between them; Rapid View of the Scale of Life; the peculiar nature of the Vital Operations enforced.

BEFORE entering upon the subject of the vital phenomena and their cause, it will be desirable to prepare the reader somewhat, by examining the chief characteristics of living objects; in order to this, let us proceed to compare some of the properties of bodies, and endeavour to point out some of their differences.

Liability to change is a remarkable character of living bodies: a rock of *granite* remains, after the lapse of centuries, *unchanged;* but the most gigantic tree may be said to live but as it decays, and its existence is accompanied with numerous changes, inseparable from its constitution as an organized object: it grows, flourishes, arrives at its maximum of strength and beauty; but impelled by the process of change, its beauty wanes, decay commences,

and the lofty oak is mingled with the dust of the earth, so that no eye can see where it stood. This disposition, then, is a grand and distinctive feature of animal objects.

But though so dependent, as it were, upon changes, and in fact, progression towards decay, yet living things have a remarkable faculty of resisting physical agents, which is not possessed by inorganic bodies; and what still more excites our curiosity, this faculty is possessed only while they live. Several kinds of plants have been found living with their roots in the water of the hot springs, the temperature of which was 174° F.; and even in the boiling springs, many Confervæ and water-plants are found. Some also have been discovered flowering in full luxuriance on the crater of a volcano, in ground the temperature of which was 210° F. Hunter discovered, too, that plants have a power of sustaining a certain temperature above or below the surrounding atmosphere, according to the weather, and that the sap of a tree might be frozen when extracted from it, though not, if contained in the living tree. But animals have a still higher power of resistance; fishes have been found living in water at the temperature of 158°; and Humboldt saw fishes thrown up alive from a volcano, in water and steam of 210°, enough to have boiled them, if not protected by their life. The experiments of Blagden and Fordyce on entering ovens are well known and will occur to the reader; that too in which the French girl entered her own oven, remaining ten minutes, and then bringing out a thermometer at 288°, is a surprising example of

this protective endowment. The reverse of these experiments is seen in cases where animals are exposed to very low temperature, as in frozen serpents and eels, and hybernating animals; in these it is very remarkable, that if the temperature be reduced below 70° the creature is revived.

In addition to these instances in regard to temperature, living animals have the power of resisting other agents; worms may live any length of time in the stomach of animals, subjected, of course, to the gastric juice; it is common also to find this powerful solvent has acted on the coats of the organ itself after death. These are all well accredited facts, and exhibit the peculiarity of the vital conditions.

Inorganic substances are either composed of various matters mingled together without any sort of arrangement, or of homogeneous matter arranged in certain forms, such as crystals: the first seems to be the result of accident, the other exhibits a very remarkable regularity, in obedience to certain laws. If solutions of different crystals be mixed and exposed to evaporation, so as to allow them to return to their original form, the crystals resulting are not compound, but each is simple and pure, both in form and composition; a force of selection or arrangement of particles has been in action, and probably maintains their proper form: of this, however, we shall find occasion to speak again.

If we break a piece of *granite*, and examine its internal arrangement, if such it can be called, we observe that it is composed of various particles of *different kinds*, mingled together without any degree of order; but if we examine a piece of *wood*, it

is easily seen that a regular and symmetrical arrangement of varying parts, called *structure*, exists; still further, if we break a *crystal*, we find that it appears to be, and in fact is, of one and the same composition throughout, and if we were to take the minutest atom of it, we should, by analysis, find it to be composed of the same elements as the whole mass. It is true, that in crystals there exists a definite arrangement of parts, but it consists in the arrangement of parts of the same kind, of the same composition and quality, which is quite another thing from the arrangement of different parts having different properties. Crystals have been found in the living animal:—"The spinal canal and the cranial cavity of the frog have, surrounding the central parts of the nervous system, a layer of white pulpy matter which, according to Ehrenberg and Huschke, consists of microscopic crystals of carbonate of lime. In the peritoneum of fishes, and in the tapetum of the choroid of the same animals, Ehrenberg* has also discovered microscopic crystals of organic matter.

"[Professor Schoenlein† has discovered, in the intestinal excretions, and in the yellow crusts covering the excrescences of the mucous membrane in typhus abdominalis, which are supposed to be Peyer's follicles, a great number of small crystals, which consist chiefly of phosphate of lime, some sulphate of lime, and a salt of soda.

"Dr. Valentin‡ has observed an imperfect crystallization of the calcareous matter which forms the

* Müller's Archiv. für Anat. und Physiolog. 1834, p. 158.
† Ibid. 1836, p. 258. ‡ Ibid. p. 256.

shell of the egg of the lacerta viridis.]"—*Müller, Elements of Physiology, translated by W. Baly.* p. 22, Vol. I.

It is remarkable that even in the lowest and most simple form of animal life, the structure is composed of a *cellular* arrangement filled with a *fluid;* thus consisting of two distinct substances existing in the same body, and necessary to constitute it a living body.

The study of chemistry has enabled us to separate and exhibit, as elementary principles, that are considered not to be susceptible of further decomposition, certain substances, which are for this reason called "simple bodies," or "ultimate elements," such as carbon, oxygen, hydrogen, nitrogen, &c. Now, it is remarkable, that animals and vegetables, and organic bodies in general, although so very different in many respects from inorganic, are nevertheless made up of the same elementary principles which form all material objects. A *crystal* can be decomposed, and its elements exhibited; *e. g.* from carbonate of lime we separate and exhibit oxygen, carbon, and a metallic substance, calcium; but likewise, if a piece of *bone* be submitted to the same process, we can separate and exhibit, as its ultimate elements, carbon, oxygen, calcium, with others which need not be mentioned. Thus, it is a startling fact, that our complicated and delicately formed bodies, with all forms of elasticity, pliability, hardness, and strength, with every variety of form and colour, are reducible to the same elements as the rocks, the trees, and the air.

Many mineral substances have of late years been

proved to exist in animal structures and fluids during life, as the following table from Müller shows.

Elementary Substances in Plants.

1. Carbon, 2. Oxygen, 3. Hydrogen,	their most essential components.
4. Nitrogen,	found less frequently.
5. Phosphorus, 6. Sulphur,	principally in vegetable albumen and gums, especially in the tetradynamia, combined with nitrogen.
7. Potassium,	almost universally.
8. Sodium,	principally in marine plants.
9. Calcium,	almost universally.
10. Aluminium,	rarely.
11. Silicium.	
12. Magnesium,	rarely.
13. Iron, 14. Manganese,	frequently.
15. Chlorine.	
16. Iodine, 17. Bromine,	in marine plants.

"The same substances, except *Aluminium*, are likewise found in the animal kingdom," in addition to which, in the teeth is found *Fluor*. "In man and the higher animals the components are:

1. Oxygen.	
2. Hydrogen.	
3. Carbon.	
4. Nitrogen.	
5. Sulphur,	met with principally in the hair, albumen, and brain.
6. Phosphorus,	in the bones, teeth, and brain.
7. Chlorine, 8. Fluor, 9. Potassium, 10. Sodium, 11. Calcium, 12. Magnesium,	in the teeth and bones.

13. Manganese, 14. Silicium,	}	found in the hair.
15. Iron,	{	. . in the blood, pigmentum nigrum, and crystalline lens.

"Copper has also been found in some, and it is said gold has been found in tamarinds."—*Müller, Elements*, pp. 1, 2, Vol. I.

From this it will be seen, that the same *ultimate elements* enter into the composition of both animate and inanimate bodies. The precise condition of such chemical substances in the animate tissues and fluids is not determined; probably it is different from that of which we are informed by chemistry. Engelhardt has ascertained that the mineral substances may be abstracted from the blood by chlorine; and Berzelius infers from this, that the iron found in this fluid is in a metallic state, but others suppose it is combined with the ingredients of the blood as a base, *e. g.* albuminate of iron. Sulphur and phosphorus are found in animals and in the brain; Berzelius thinks phosphorus exists in a fixed and pure state. Crystals of common salt may be obtained from animal matters, and the phosphate of lime of the bones exists in them as phosphate of lime, and not as the elements of that salt; it is considered to form a salt with the cartilage. But all the elements which form inanimate objects do not enter into the composition of living bodies, and some are positively destructive of life: of the fifty-two elements known, eighteen only have been discovered in animals and plants.

Certain of what are called *proximate* elements are found in living bodies, which are not discovered in

inorganic substances, and these are so far characteristic of living bodies, as fibrin, albumen, gelatine, &c.; these substances, although formed of the general elements we have spoken of, yet, it is supposed, owe their properties to a peculiar arrangement of them, which chemists call "*constitution*," and which, in all probability, is dependent upon the vital influences they have been subjected to. It cannot, however, be said at present how far heat, light, and electricity are concerned or not in the constitution of these substances, yet we imagine it would be difficult to produce any of them without the agency and influence of life and vitalized tissues. Several eminent chemists think they have succeeded in producing organic compounds by artificial processes; but their results have not been confirmed.*

There is an important and remarkable difference in the *chemical composition* of animate and inanimate bodies. A *mineral*, as for example, carbonate of lime, is composed of two substances united to form another, which has different properties from either of its constituent elements; such a union is called by chemists, "bi-elementary composition." But an animal substance, as for instance, carbonate of ammonia, is composed of four elements instead of two, viz, carbon, oxygen, hydrogen, and nitrogen: this kind of composition or chemical union is universally found in organic bodies.

Another character of organic bodies is, their *combustibility*; we can burn wood, or hair, or silk, or flesh, but it would be very difficult to burn granite. The rationale of this phenomenon, although chiefly

* See Müller, p. 3. Vol. I.

to be found in the affinity of the components of organic bodies for oxygen, nevertheless involves intricate points in chemistry, which it is not convenient here to enter upon; the fact is enough for us at present.

We have before said, that a cellular structure, capable and adapted for holding and containing fluid, is a distinguishing character of living subjects. In minerals, fluids are sometimes found enclosed within the structure, but these are merely "imprisoned," and are not necessary to the properties of the mineral. This compound arrangement forms the basis and substratum of life or vital manifestation: the conjunction of fluids and solids is of the greatest importance, for if the living structure be deprived of its fluid, it no longer exhibits signs of life. If a polype be dried, it will no longer exhibit signs of life, but if moistened again, it recovers its life. This fluid is aqueous, four-fifths of the weight of all the tissues being water; it is the same, so far as we are able to analyze, as any other water, and we can separate it from animal or vegetable tissues as water; yet we are not justified in concluding that it exists in them in the common form with which we are all familiar, for we cannot perceive it there as such.

The use of fluids in the living structure is evident; we know that solution is the simplest form in which organic matter appears; by this means, aided by the beautiful machinery of the circulation, organic particles are supplied to the living structure. The air-plant, as it is called, flourishes suspended by a thread in the air, having the power of deriving

nourishment from the air and the moisture it contains. The little globular infusory animalcule, consisting merely of a transparent globule or vesicle filled with fluid, is the lowest example of animal life, and in its economy bears a close resemblance to the air-plant or the Fuci; it derives its nourishment simply by imbibition through its sides or surface. In the polype, a small animal shaped like a bell with the small end fixed, the nutrient fluid flows over it, and is kept some little time in contact with it, by the cup shape of the creature; in sponges and corallines a similar form is seen. In the "*branch polype*" we first see a cavity in the centre of the structure, into which the fluid containing nutriment flows; ascending the scale, we find that as the state of organized structure advances, (in those we have alluded to, the structure is little more than homogeneous, simply cellular, and perhaps scarcely to be distinguished from that of plants,) and as other structures and complicated organs require to be formed and nourished, the provision for nutrition becomes highly complicated and mysterious; a central cavity is provided, in which curious and inexplicable changes are effected upon the organic particles taken as food, and perhaps a quality of vitality is conferred upon them; they pass into tubular vessels, which convey them to the most distant parts of the body, where, in a mysterious manner, they become identified with the living structures, and for a time perform the duties of living particles, until, by the process of constant change to which we have alluded, they become eliminated and set free, either by the ordinary process of waste during life, or by the decom-

position occurring after death. The process of organization is called by some physiologists, deposition, and by others, secretion; but it remains to be explained, how organic particles are vitalized, and then how they are assimilated to the various tissues and structures of the body, how they are organized, in fact.

It may be said that all this is very clear and easy to be understood, and quite in accordance with natural laws as affecting bodies generally; that the structure of an organic body is not more complete than that of a crystal, in which we saw a force of selection exists, for it is well known how particles may be added to like particles by force of aggregation; and are not our bodies nourished by the supply of similar particles to those of which they are formed, a phenomenon not beyond explanation by the laws of natural philosophy, and which might be anticipated; that like all particles of matter, when death occurs, so the matter of our bodies is restored to the general mass and returned to the general "storehouse of nature;" but yet it would remain to be shown why the vital processes of which we have treated should not continue in operation in the same structure for ever, at least as long as this mundane condition exists, which is not the case, for we know that plants and animals certainly have not been in existence for ever; they were *created*, an occurrence incompatible with an eternal existence.

These remarks lead us to speak of another attribute of living bodies, *their mode of origin*. We can create a mineral, or chemical compound, by the bringing together and union of its elements, but

the same result cannot be effected with the elements of an organic structure. No mineral can be said to have the property of creating any thing like itself in properties and qualities, but all living things are endowed with this power, possessing it in virtue of their *life.*

We have seen, then, that certain phenomena are due to the existence and operation of a principle distinct from and unlike any thing connected with the material world; by this we do not mean to uphold the doctrines of the vital principle school, or those which teach the entity and substance of "*life,*" but employ such an enunciation in order to lead the reader gradually to entertain an idea of "*mind*" and thought, by showing the analogy between the principles, so to speak, of "*life*" and "*mind.*" As to the source and cause of such a principle, we must be content to confess our ignorance, and admit that the grand and stupendous idea of "*life*" was conceived by the Supreme Intelligence, and the union of vital properties with matter in the human body was designed to exhibit the most wonderful thing in the universe—the action and manifestation of the human spirit with all the mysteries evolved by thought and emotion.

But we proceed to speak more particularly of the vital operations, the existence of which, as a distinct fact, we have endeavoured to render evident and comprehensible.

VITAL PHENOMENA.

A. *Phenomena of life that may be observed and studied.*—Certain phenomena may be mentioned as the general result of organization, both in plants and animals; these are, "excitability," "development," "growth," "maturity," and "propagation," with "decline," "dissolution," and "decay:"—it might be desirable to enumerate the differences between plants and animals, but as they do not especially concern our general purpose, we shall only first state that there are other properties peculiar to animals, and which are consequently called "animal;" they are "sensation" and "voluntary motion," with some others which need not be specified at present.

We shall commence the consideration of these phenomena with that which may be looked upon as the nearest link to those exhibited by inanimate objects, and one of the simplest vital effects, viz. "*Motion:*"—

a. Certain movements are seen in *plants* which are dependent upon their vitality, and may be called vital phenomena, as the motion of the sap, the turning towards the light and sun, climbing by various hooks and tendrils, and the extension of their roots; with the various motions in the Mimosa, the action of the Fly-trap, and the interesting effects visible at the time of impregnation in flowers.

Amongst the most remarkable and interesting examples of this function may be mentioned the rising of the water-lily flower above the surface of the water in the morning, and its retiring at sunset beneath the water with its flower closed; the movement of the leaves of the Hedysarum gyrans, exhibiting a constant elevation and depression, independent of stimuli; of the well known sunflower, the "follower of the sun;" the turning of the hop-plant from east to west, which, if thwarted in its course, actually dies: those examples also, in which plants have been inclosed in a darkened room, with only one aperture for light, to which they always climb, are highly curious and difficult to explain; but the fact of the Cuscuta twining only on living plants, Müller seems to think, exhibits an organic attraction, and that the motions of stamens and leaf-stalks have too much resemblance to the irritability of muscles not to be compared to it. Dutrochet has discovered that in the Mimosa, to which the sensitive plant belongs, this irritability resides in the cortical part of a swelling situated at the articulation of the leaf-stalks; when this was removed, no motion could be excited; when the upper half was cut away, the leaf was elevated, but not depressed again, he considers that some controlling action is exercised at this part, and others have noticed a change in its colour at the time of movement: the roots of plants also exhibit a similar disposition; they always shoot towards those matters which will yield proper nourishment to the plant: if a wet sponge be placed near the roots of a growing plant, they will go towards it, and if the sponge is moved the course of

the roots will be altered accordingly. Some of these movements occur spontaneously, others are not produced without the presence of a stimulus or irritant of some kind, such as mechanical force, electricity, heat, or chemical agency: but if the plant is *dead* none of these phenomena occur; they are said to be the result of "irritability," another term for "life."

Lindley says, "Numerous plants move with all the appearances of spontaneity; the spores (seeds) of those Confervæ, which are sometimes called Zoosporous, swim in water with great activity: the filaments of Zygnemata combine with the energy of animal life; and as for a stomach, it is impossible to say that the whole interior of a living independent cell is not a stomach." *Vegetable Kingdom.* And again, speaking of Confervæ, "It is curious to see how much, at one period at least of their existence, they have of an animal nature, if the power of moving from place to place is to be taken as an indication of such a quality. It seems incontestable, notwithstanding the denial of Mohl and others, that many of the Conferva tribe, especially of the genera Conferva, Ulva, and their near allies, produce in their tubular threads reproductive bodies, or spores, which after a time acquire a power of rapid, and quasi-voluntary motion while in the inside of their mother; that by degrees, and in consequence of their constantly tapping against the soft side of the cell that holds them, they escape into the water; that when there they swim about actively, just like animalcules; and at last retreating to a shady place, attach themselves to a stone or some other body, lose their locomotive

quality, and thenceforward germinate and grow like plants. It is even asserted by M. Thuret, that in Conferva glomerata and rivularis, the spores have special organs of motion, of the nature of ciliæ or tentacula, and that it is by their rapid action that the spores swim so freely in fluid. Motions of another kind have been noticed in the Oscillatorias; and in the species called Zygnemas, they are so extraordinary as to approach nearly to the act of copulation in animals."

Agardh says of the same, "At first they issue in a body, but soon those which remain, swimming in a much larger space, have much more difficulty in escaping, and it is only after innumerable knockings (titubations) against the walls of their prison, that they succeed in finding an exit. From the first instant of the motion one observes that the granules or sporules are furnished with a little beak, a kind of anterior process, always distinguishable from the body of the seed by its paler colour. It is on the vibrations of this beak that the motion, as I conceive, depends. The sporules, during their motion, always present this beak in front of their body, as if it served to show them the way; but when they cease to move, by bending it back along the side of their body, they resume the spherical form, so that before and after the motion one sees no trace of this beak. The motion of the sporules before their exit from the joint consists principally in quick dartings along the walls of the articulation, knocking themselves against them by innumerable shocks; and in some cases we are almost forced to believe that it is by this motion of the sporules that the mammilla is formed.

Escaped from their prison they continue their motion for one or two hours, and retiring always towards the darker edge of the vessel, sometimes they prolong their wandering courses, sometimes they remain in the same place, causing their beak to vibrate in rapid circles. Finally, they collect in dense masses, containing innumerable grains, and attach themselves to some extraneous body at the bottom or on the surface of the water, where they hasten to develop filaments like those of the mother plant."

Unger says of the spores of the Achyla prolifera, a species of Conferva that often attacks fishes as a parasite, and frequently kills them, that he has seen them stick fast in the hole from which others have escaped, as described above, and perish there; they are about the $\frac{1}{2000}$ of an inch diameter, but he declares he has seen them die, struggling convulsively in the agonies of death: lastly, it has been observed by Meyen, and since by many others, that the cells of the antheridia of Mosses contain bodies which seem to possess spontaneous motion, and resemble the spermatic animalcules; they are described as spiral threads with a thick body, in length about the 0.01 of a line, and visible by a power magnifying 600 diameters; they have the power of moving about in water in any direction: the filaments of Oscillatorias are continually writhing like worms in pain: the rapid movements of the minute particles composing the fovilla or contents of the grains of pollen, discovered by Gleichen, are also a very remarkable example; these measure from the $\frac{1}{4000}$ to $\frac{1}{30,000}$ of an inch in length, and their movement is admitted by all.

What can we say of the real nature of these movements? From the great simplicity of their mode of existence, we should hardly expect to find in these plants any thing like voluntary motion; Lindley leans to the opinion that they are dependent upon hygrometrical conditions; he says, "there is as active a motion in the Elaters of Equisetum as in the Spirilla of Mosses, only it arises in the former from drying, and in the latter from floating in the water." Still many do not hesitate to pronounce them animal, and we have no positive proof that they do not feel or will their movements.

In animals the analogous phenomena have this peculiarity, that an *external* stimulus is not needed to produce them, they are the effect of the voluntary operation of one organ, the brain, or an analogous structure, and are generally accompanied by sensation and consciousness, and even in the lowest animals that exhibit life this holds true; voluntary motion being accompanied for the most part with sensation and consciousness, of which there is no existence in plants, is then widely distinct from mere motion from irritation.

But it may be said that *brute matter* is endowed with "*motion.*" Let us compare this action with that we have been speaking of as the property of animals and living objects in general.

When we consider the motion occurring in a mass of inanimate matter, it becomes evident that the mass is the subject of a relative force which exists independent of the mass itself, and in fact refers as much to other masses as to the one in motion; indeed, so far are we from finding any evidence of the

possession of a tendency to motion by the mass itself, that positively we find there is just the reverse, a tendency to remain at rest, a "vis inertiæ" which must be overcome by a foreign and superior force, before motion can be produced. Now the case is widely different in the living organism, for in that structure motion is produced from within, as a property of the organism itself, which is "active," and not necessarily subservient to any external and foreign power, and the force is not relative.

Thus, then, "action," and the capability for action, are especially vital phenomena, and are seen more completely in animals, and pre-eminently in the highest of them. Voluntary motion, accompanied with sensation and consciousness, which faculties will be further considered at another portion of this section, is more highly vital in its nature, inasmuch as it is not seen in the vegetable world, where the vital phenomena are in action, though not in the refined and peculiar manner exhibited in animals.

b. Growth.—We have referred, in the introduction, to a process of increase in *mineral* bodies by the aggregation of particles, or by reason of the "attraction of aggregation" as it is called: in such cases like particles attract like, and combine to form a regular symmetrical mass or not, as the case may be; in some substances it is a process requiring much time, in others it takes place rapidly, as in crystallization; the converse of this is seen, however, in the crystallization of metals, which is a very gradual process. It may be well to state here, that these processes are influenced, as regards their rapidity, by electricity: this should be mentioned, on account of

the views taken by some as to the importance of the electric force, and its analogy, if not identity, with the nervous energy. Now in *plants* a process of increase, by the addition of new matter of the same kind as the old, is seen, and at first sight it would appear to be similar, but on examination we find, that in plants *unlike* particles are attracted and selected, and even decomposed, in order to be applied for the nourishment and growth of the plant; in the higher plants, consisting of various parts and organs, from the general sources of nutriment, the soil and the air, are selected the nutrient particles for all the varying structures, the pith, vessels, woody fibre, leaves, stalks, flowers, &c. each of which may be possessed of peculiar properties, but all attracted from one source. Although crystals have a determinate form and a symmetrical arrangement of particles, yet they, as well as all minerals, are the same in every part: they do not consist of differing structures combined to form *a whole;* but it must be said, that the development of the geometrical forms of crystals in such precision is highly curious, and cannot be satisfactorily explained at present.

In animals, every one knows very well what "growth" means; a young animal increases in size by the addition to its structure of organic particles derived from the food it receives; in the delicate tissue of its body are deposited particles which are appropriated and adapted to each structure, whether bone or muscle or cartilage, sinew or tooth or hair. The mode in which this occurs can scarcely yet be explained, though it appears that the various matters to be deposited escape through the sides of the very

minutest blood-vessels by a sort of filtering or permeation. Some physiologists have brought forward the instances of two young animals united by some part of their bodies, as the back, legs, or arms, face, &c. to prove that a force of attraction of like for like exists in the animal economy, but these cannot be admitted as proving the point, for they may be caused by a tendency to adhesion, similar to that seen in vegetables. We often see apples and other fruits grown together, merely as the result of contact, in conjunction with that disposition to adhere, common to vegetables that we have referred to: if such a force existed at all, it must be always in action when the conditions favourable to it are fulfilled, which is not the case, for the instances we have referred to are curiosities, and exceptions to the general law: Müller has carefully examined the parts of live animals, under the microscope, and has never been able to see any thing like the action of attraction.

We have not succeeded, then, in showing the existence of any thing like or equivalent to the "assimilation" belonging to the organic structures, in the process of growth or accumulation of mineral bodies, so we must admit that this "growth" is peculiar and dependant upon the "life" of the organism.

C. *Nutrition.*—There is another phenomenon closely allied to that of growth, which we have seen occurs before the time of maturity, proceeding after maturity, and even during the process towards death and decay, in a qualified manner; it is that process by which fresh particles are supplied to parts already

complete in their structure, in order to fill the place of those which are eliminated by the disposition to change and waste to which we have alluded, as characteristic of animate objects; this phenomenon is peculiarly distinct from any thing occurring out of the animate world, and we propose to treat further of its character; it is called by some deposition or secretion, or by others permeation.

We have alluded to the nutrition of sponges and infusory animalcules, by imbibition; in plants a similar process occurs at the spongioles of the roots and at the surfaces of the leaves; a little higher in the animal scale than the sponges, we see in the polypes there is a cavity running down the body of the animal, into which the water containing nutrient particles always enters and passes out. Amongst the infusory animalcules Ehrenberg has discovered that the smallest, not more than the $\frac{1}{200}$ of a line in diameter, possess a complicated stomach and organs of motion, in the form of cilia; in some polypes the nutrient fluid passes in at one opening and out at another, which may be considered as the rudiment of the digestion and circulation of the higher animals. This step leads us to speak of the process in the highest animals, in which it is found that nutritious particles, after due preparation by the stomach and intestines, are absorbed, from the general contained mass, through the tissue of the lining membrane of the intestine, by the process of imbibition or permeation to which we have alluded, and thus finding their way into the absorbent vessels which form a minute net-work in such tissues, arrive at the blood-vessels and heart, which powerful

and active organ propels the whole mass of blood, charged with fresh nutriment, to the extremest parts of the structures, where, in exceedingly minute vessels, called "capillaries," important vessels intermediate between the ends of the arteries and veins, very minute, and forming a very delicate net-work in the tissue of every organ, however small, probably many very important changes occur; and which are the instruments in this process of nutrition: probably it is by the simple process of permeation that particles are separated from the nutrient mass, each organ and particular tissue receiving its proper particles; the size of these may be understood from the measurement of the blood globules, which are $\frac{1}{4600}$ of an inch, and the chyle $\frac{1}{7190}$ of an inch diameter:—and thus the wear and tear of the living frame is remedied. This process, it need scarcely be said, ends with life, and is dependent upon life for its action; there are, however, some processes of growth or nutrition of certain structures which can scarcely be called vital, and it must be observed that they are distinguished by their products which are not vital; such are the growth of the hair, nails, teeth, and scarf-skin—all these structures grow by means of simple exudation from the surface of a vascular and living pulp, or "matrix," as it is called.

D. *Reparation.*—Another highly interesting and especially vital phenomenon is to be seen in the *reparation of injuries*, after various wounds and abstractions of parts of tissues. A wound is healed by the close adhesion of its sides, between which is effused a peculiar substance capable of becoming

organized, and afterwards performing the function of those parts in which the injury has occurred; new blood-vessels are formed in this substance, which are soon followed by the other important structures, such as nerves and absorbents, and render the organization complete in every respect; even very considerable loss of structure is supplied in a similar way, and a remedy is thus afforded to the injury. In some of the lower animals, as the *salamander*, *lobster*, *insects*, &c. even a limb may be regenerated almost equal to the original; and if a part of a limb be cut off, the injury is equally well repaired; even the eye of the Newt has been cut out and quickly reproduced, according to Blumenbach's experiment. Our limits will not allow us to enter into the proper description of these very interesting processes, but it is surely evident that they are especially vital, and never seen but in living structures.

Were it convenient, we might now discuss the phenomena of digestion, circulation, and respiration, which are peculiar to the higher animals, but as we have alluded to the types of these functions observable in the lower and simpler animals, the action of the vital organism has been sufficiently illustrated. We therefore proceed to speak of another highly curious condition of the vital property.

E. *Generation.—All living things are endowed with the means of giving rise to new creatures like themselves.* The great miracle of creation has been once performed, and will never be repeated, so far as our existing economy is concerned; by that act each living individual contains, in virtue of its life, a "germ" or seed which holds within it, indepen-

dently, the essence of life in a highly curious and mysterious manner. We find that this property may lie dormant or latent for almost any length of time, until the proper conditions for setting it in action are fulfilled; thus seeds taken from the hand of a mummy have, after so many centuries of quietude, given rise to their ancient plant. A similar and corresponding phenomenon may be observed in the egg; under the proper circumstances of light, heat, and air, the vital organization shows its activity, the germ, no longer tranquil, unfolds itself obedient to this force, its parts are developed, and the delicately formed bird is soon to be discovered; yet it is to be remembered, that the perfected animal retains this property, in that concentrated form which we have described, as the potential germ of another creature. It is remarkable that in the individual resulting from the germ sprung into an organized, or as some would describe, unfolded condition, the number of fresh germs produced is not one but many; the reproductive power of plants from some seeds is surprising, often fifty or a hundredfold; the number of ova sometimes found in fishes is even more wonderful, all of which may be said to spring from one germ: in the higher animals the faculty is much more limited, although the number of young ones is never so great as that of the germs possessed by the parent. Thus the multiplication of organisms is kept up, and the force of organization never ceasing to act or exist, may be said to have a kind of immortality.

The duration of life in any organism is limited, the germ becomes the infant which passes through

the efflorescence of *youth*, and arrives at the state of *manhood*, but passing on to that of *old age*, the "second childhood," "decay" shows itself, and the conditions of life soon vanish at death; the matter inhabited and qualified by their presence is no longer preserved from the resistless elements; the particles forming the organic mass, now devoid of life, begin to act on each other, the integrity of the structures is destroyed and broken up, the air and heat and light act upon them, and very soon that splendid structure, which had been cemented and held together and moved by "life," is not to be distinguished from the dust.

It has long been asserted that living creatures may be created by artificial means; some observers say they have seen animalcules formed in pure water, others in solutions of granite, chalk, and marble, and Retzius, that he found a peculiar kind of conferva in a solution of muriate of Barytes in distilled water kept half a year in a glass stoppered bottle. Müller's introduction to this subject is so good, that we extract it.

"*Equivocal generation.*—The ordinary mode of production of organic beings is from others of the same species, by ova or shoots. But it must be inquired, whether the organic matter left after the destruction of one living body can, under certain circumstances, generate living bodies of another kind; whether it is capable, not only of nourishing bodies already living, but also of continuing its own life in a modified form; whether, in fact, under certain conditions,—namely, under the influence of atmospheric air, water, and light,—small microscopic

animals, the infusoria, and under other conditions the simplest plants, forming mould, are generated from this apparently dead organic matter.

" In a more extended sense the ancients, especially Aristotle, had admitted this equivocal generation, this spontaneous formation of animals; for they had an old tradition, that the lower animals, insects and worms, were generated during putrefaction. This opinion was still maintained among the other superstitions of natural history and medicine even in the seventeenth century. At that period Redi wrote his 'Experimenta circa generationem insectorum,' in which he proved that all the instances of equivocal generation, which the ancients had adduced, were erroneous; that all these worms and insects were produced from ova which had been previously deposited. His proofs were convincing, and from that time no well-informed naturalist believed in the fable of generation by putrefaction; so that the proverb, 'Omne vivum ex ovo,' retained its force. Subsequently, however, Needham pointed out, that although no insects are produced by putrefaction, yet that, during that process, minute microscopic animals till then unknown are generated. If water is poured over animal or vegetable substances, and the infusion exposed to air and light at the usual temperature of summer, after a few days the organic matter will have undergone partial decomposition, being in part converted into other organic matters, partly reduced to globules, and in part dissolved; and there will appear in it either mould, or those microscopic animals, in which Ehrenberg has discovered a very complicated organization." The most important ar-

guments in favour of spontaneous generation are those of Terviranus:—viz.

"1. Infusions, with the same water, of different organic substances,—for instance, cress-seeds and rye,—give rise to different animalcules.

"2. Light has a very great influence on the process of equivocal generation. When water, particularly spring water, is exposed to the sun in transparent vessels, whether open or close, this matter appears in the form of a greenish crust consisting of round or elliptic granules, in which crust at first the slight motions of single molecules are discovered, and afterwards transparent threads moving irregularly.

"3. The entozoa and the spermatozoa, bodies with tails and spontaneous motions, which are seen by the microscope in the seminal fluid, even of invertebrate animals, seem to afford arguments for the spontaneous origin of living beings in organic matter.

"4. Treviranus found in his own experiments that, under circumstances otherwise similar, different organic beings, namely infusoria or mould, are formed in different infusions; and he found that these differences did not depend on the water, but on the substances infused in it.

"5. Treviranus observed that in one and the same infusion, under different accidental conditions, different animalcules were developed; thus, from an infusion of the leaves of the iris with fresh spring water, in a long vessel covered with linen, and exposed to the sun, infusory animalcules were generated; in another vessel, placed in another situation, the green matter of Priestley was formed. Thus also

the products in the same infusion of rye with spring water were different, when Treviranus placed a bar of iron in one of the vessels. This result seems to agree with that of Gleditsch, who found that in separate portions of melon covered with muslin, and placed at different heights, the various living organic substances, namely, mould, byssus and tremellæ, were produced in different proportions. To this might be added, that Gruithisen states that he has found perfectly different animalcules in infusions of pus and mucus."

To these we may add the well known experiments of Mr. Crosse with solutions of Silica and other mineral substances exposed to weak galvanic currents, in which peculiar insects are said to be created, and which have been even named after their discoverer; but we cannot help telling the amusing fact, that one of these, sent to Dr. Brown the botanist for examination, was pronounced by him to be a carrot seed.

This subject is of so much interest, that we venture again to quote Müller's arguments against equivocal generation.

" 1. In the experiments made with boiled organic matter, in the air, it is not certain that the infusoria or mould did not arise from the dust of desiccated animalcules, or their germs, floating in the air. Perhaps, as Humboldt remarks, when waters on the surface are dried up, the winds take up the germs of the simplest organic beings, which, being received by other water in the form of dust, are revivified, as in the well known and attested fact of the revivification of the wheel animalcule, first observed by Spallanzani.

The fact of the dust which floats throughout the air containing particles which swell when moistened, has very recently been applied by Schultze to explain the production of infusoria; he regards these particles as monads, which have been dried, and which when moistened recover life. Schultze, however, does not consider this very frequent source of infusoria as the only one; he admits the conversion of organic substance into protozoa.

" 2. The equivocal generation of infusoria is not better proved by the experiments in which boiled organic substances and common water were used; for the water may have contained the ova of infusoria, or animalcules themselves, which have afterwards multiplied very rapidly at the expense of the organic matter in the infusion. The use of perfectly pure distilled water can scarcely be presupposed, for even water distilled five times may still contain organic particles.

" 3. Those who have experimented with fresh organic substances and distilled water, or even artificially prepared gases, cannot prove that the ova of animalcules, or animalcules themselves, were not in some way contained in the organic substance: the microscopic animalcules which are known to exist in living tissues are indeed few, and the common globules of the organic fluids, such as those of the blood, have certainly no individual life; but mucus itself contains microscopic animals; the intestinal mucus of the frog, as well as the semen, contains animalcules. Baer has seen microscopic particles moving spontaneously at different spots in the muscles. The grain of wheat, and some varieties of agrostis, often

contain vibriones, which even after being dried recover their active life if moistened. Some animalcules also which are met with in other animals, but especially the epizoa, will continue to live when placed in water.

" 4. Lastly, although some experimenters should have employed organic substances long boiled, with distilled water and artificially prepared air at the same time, still the accuracy necessary for a sure result is neither probable nor generally possible, since every instrument used for changing the water ought to be absolutely free from particles of organic matter, and every cleansing is a source of errors."

He goes on to say, that Ehrenberg, the celebrated microscopic examiner, is opposed to the theory; he has discovered the real germs of fungi and mould, these seeds may always be diffused in water and the air; he has seen in animalcules about the $\frac{1}{2000}$ of a line diameter the ova and the propagation by ova, but he has never succeeded in obtaining different forms of infusion according to the nature of the infusion, even in the most similar mode of performing the experiment; he cautions against the fallacy of mistaking the transition states of animalcules for perfected states of different species; he concludes that, like other animals, all infusoria are propagated from ova, and leaves the question as to the origin of the ova undecided. But there are still other facts relating to entozoa favourable to the theory of equivocal generation.

" *Facts relating to Entozoa, favourable to equivocal generation.*—The primitive formation of certain animals from animal matter, till then unorganized,

is still best supported by the facts regarding the entozoa. A complete series of arguments in favour of equivocal generation rests upon the impossibility of explaining the first production of entozoa, without supposing a spontaneous generation. 1. The immense majority of the intestinal worms are quite distinct in their organization from all the beings which are met with out of the animal body. The similarity of some distomata to the planariæ of fresh and salt water is only apparent. 2. A small number only of intestinal worms occur in different genera of animals. Thus the Tænia of man is peculiar to him; on the contrary, the Distona Hepaticum, the hydatid of the liver, seems to be common to man, the hare, cow, camel, deer, horse, and hog; the thread-worm, Ascaris Lumbricoides, is common to man, the hog, ox, and horse. Most animals have their peculiar intestinal worms, differing specifically from those of others. 3. Many of these entozoa occur only in particular organs. 4. Intestinal worms generally die when removed from the animal body. 5. They have been observed even in the embryo. 6. The fact of animals, which feed on vegetables solely, having nevertheless their own peculiar entozoa, proves that these entozoa, or their germs, cannot be introduced with the food. In carnivorous animals this introduction of the entozoa from without can be admitted in very few cases only; such are the facts of the Echinorhynchus of the field-mouse having been sometimes found in the falcon, the worms of the frog in serpents, the Ligula of fishes, the Bothriocephalus solidus of the stickleback, and the intestines of wading and swimming birds. But many other

entozoa are met with in other parts than the intestinal canal, and beyond the reach of matters introduced from without."

Ehrenberg thinks the ova circulate in the fluids of the body, the embryo in which entozoa exist may have received them from the fluids of the mother, even in the eggs of birds; but Müller thinks this view not feasible, for they could not pass through the capillaries, the diameter of which is only $\frac{1}{4000}$ of an inch, unless a small portion of an ovum be capable of propagating.

"M. Von Baer has observed many other extraordinary circumstances in the generation of the entozoa. The animals which he names Bucephalus, are generated in thread-like ovistocks, which are found im muscles; and Bojanus and Baer have described a worm, found in the lymnæus stagnalis, which again contains numerous animals of a perfectly different form,—the cercaria. Nordmann has seen monads in the body of living intestinal worms, namely, diplostomata; and has seen infusory animalcules produced in the interior of the putrefying ova of lernææ. On the other hand, the changes which certain entozoa undergo deserve attention; for example, the ligula and bothriocephalus solidus of fishes have no distinct genital organs until they are received into the intestines of water birds: some young distomata have at first a different form from that which they afterwards present; thus the distoma nodulosum of the perch has, according to Nordmann, at first no sucker, and is, then, provided with a trace of an eye and with cilia, as if to swim in water. The infusoria and entozoa of living plants

still require investigation. It is important to know, that the diseased grain of agrostis or bent-grass, phalaris or canary-grass, and wheat, contain, according to Steinbuch and Bauer, vibriones; that Bauer, having inserted vibriones into the stem of the young wheat, found them again in the grain; and that the worms of the dried seeds, according to the same observers, if placed in water after several years, will again present all the phenomena of life."

The origin of organic matter is still mysterious, for we see that it is necessary for the production of the infusoria, and its pre-existence must be supposed, for it is not produced spontaneously; plants alone have the power of living on inorganic elements.

But, lastly, we must speak of other phenomena peculiar to animals, and especially observed in those of a high standing in the scale; and first of

f. Sensation.—Every one knows what it is to "feel:" if any animal is burnt or scratched, it shrinks from the offending object and expresses pain; it has been said that the same thing occurs in the sensitive plant, which, if burnt with a hot wire, or touched even, exhibits a peculiar action; it droops, and may be killed by a repetition of this operation: we cannot allow ourselves to enter fully into a description of this process, suffice it to say, that in the structure of this plant we see nothing different from that of others, but the peculiar form of its leaf-stalk and leaves is adapted for such a hinge-like action. Moreover, the effect produced is always exhibited by a motion in a determinate direction, which is not the case in the analogous motions in animals; again, there is a

very great difference between the structure of this plant and that of animals, and there is no reason whatever for thinking that *sensation* accompanies such phenomena in plants. It is not necessary to enter upon a long description of sensation, and we shall have occasion to speak of the theories of sensation in another place.

g. Voluntary motion, in animals, is accompanied with consciousness of sensation, and often with the exhibition of motions and actions guided by the power of the will; even in the lowest animals this would appear to be the case; many persons have seen what a troubled arena of warfare and contentions the field of the Oxyhydrogen microscope becomes, and how formidably all the combatants are armed; all the appearances of anger and pain are exhibited by these little creatures, although they are so small as to be quite beyond the sight of the unaided eye. These facts sufficiently distinguish motion in these creatures from any which can occur in inorganic matter, and hence it takes the name of "voluntary motion."

It might be expected that the mental and instinctive properties, as peculiar to animals, should now be entered upon; but as these subjects belong to the second part, we shall be content with merely reminding the reader of them as distinctive of animal life.

B. *Of the conditions necessary for the manifestation of the vital phenomena, and the circumstances that influence and modify them.*

We have seen that the various phenomena above described are to be found, strictly speaking, only in the class of animate objects; that without the exist-

ence of life and organism these phenomena are not exhibited; it has also been stated that living creatures, whether vegetable or animal, have the power of conferring vitality upon dead organic particles taken into their structure by nutrition; therefore we infer the existence and operation of the vital property, or "life," whatever its nature may be, and proceed to state the conditions of structure necessary for its manifestations; for this force cannot be said to exist without organic structure as its medium.

What then is normal organic structure during life?

One of the simplest instances is in the *polype.* This little animal may be described as a small membranous pouch or blind tube, the particles of which are composed of a delicate tissue of a cellular or spongy nature; the signs of life in it are exhibited only as long as it is in a moist condition, if deprived of water it dies; it derives its nourishment from this source, although it seems to be immaterial at what part of its body the process of nutrition takes place, for if it be turned inside out the creature lives equally well: its structure is composed wholly of very minute cells formed in a tender and delicate membrane, which is supplied with nutriment by permeation of the liquid containing nutrient particles. *In plants,* a similar arrangement as to cellular structure is found, but the nutrient particles which in the polype were absorbed from the general surface, are here conveyed in appropriate vessels to the structure; the cellular or porous structure of the leaves which must be in contact with the air, is also necessary to life, for if they are varnished over the plant dies. Now as to the higher animals; we still

find in all the structures exhibiting vitality a similar or analogous cellular tissue, forming an intricate network of meshes, in which are contained the various particles forming different structures and organs; this general tissue is continuous throughout the whole body, and forms its grand foundation, as it were, in these highly organized animals; we find the provision for the conveyance of fluid is complete, for the minute blood-vessels form a delicate net-work in the tissue of all the living structures, through the sides of which vessels the organic particles, probably already become endowed with vitality, permeate: in addition to these blood-vessels the structure is supplied with delicate branches of nerves, which ramify in company with the vessels; these nerves act an important part in the vital phenomena, but we are not yet in a condition to speak fully of them; other minute vessels for conveying fluid, distinct from the blood-vessels, are also to be seen, which are of great importance, called the lymphatics; of the lungs, too, we need not say more than that they are the organ especially designed for affording the contact of air, which is equally necessary for all living things.

Now this complicated arrangement, which we have just briefly described, while it contains all the conditions fulfilled in the simplest form of organization, yet must be looked upon as a more complete and perfect arrangement for the manifestation of life, and as it is found only in animals high in the scale, there is no doubt of its being, in connection of course with the air, heat, electricity, and light, the necessary means of vitality of the highest grade, such as we observe in man and the highest brutes.

As to the circumstances that modify and influence vital phenomena.—1. *Moisture:* we saw that if the polype is deprived of its moisture, it is deprived of life; plants would suffer under the same circumstances in a similar manner, and the same result would occur in the human body were it possible to make the experiment: chemical agents, which act by uniting with the water of the tissues, destroy the vitality at the same time: so fire, both as it acts in this way, and by actually consuming the parts, is a powerful destroyer of the tissues and the vitality.

2. *Supply of arterial blood.*—It is also well known, that if the supply of blood to a part be entirely cut off, the portion thus deprived of its blood dies; again, if the supply of this fluid, which is the natural and proper stimulus and source of nourishment and life to all organic animal structures, be lessened, the part is weakened; if more than the natural quantity flows into it, the structure is injured, and death may be caused equally by one or the other: but all blood will not suffice to produce the signs of vitality and keep up the action of the living structures, for if this fluid does not contain fresh and new particles that have never been deprived of their nutrient and vital powers, and that have been aerated and purified in the lungs, vitality is destroyed; in cases of drowning, hanging, and suffocation, death is caused from the want of a due supply of properly aerated blood in contact with the brain: in these cases the effect is remarkable, for it seems to be caused by the want of the proper influence of the brain over the breathing apparatus

and heart, which is in ordinary circumstances kept up by the due supply of arterial blood to that organ; it is curious too, that in cases where life is not quite extinct, the application of electric or mechanical stimulus prolongs and sometimes recovers life.

Since by means of *digestion* nutrient particles are prepared for the supply of the structures, and by *respiration* particles that are partially deprived of their power, and rendered effête in some measure, are renewed, these processes or functions are highly important; if digestion be impaired, or wholly prevented, no nutrient particles are received into the blood-vessels; if respiration is prevented, however nutrient the circulating mass of blood, unless it be aerated by the action of the air in the lungs, its powers of keeping up the conditions of vitality are lost.

These processes of circulation, respiration, digestion, nutrition, secretion, and perhaps the nervous controul, are attended with the development of heat, which can be mainly accounted for on common principles of natural philosophy.

3. *Caloric.—A certain amount of heat* which all animals possess is a condition also necessary for the vital phenomena, and in a certain sense may be considered as a characteristic of animals. The temperature of the blood in cold animals is equally maintained, usually above that of the surrounding medium, and is said to be cold by comparison. Were it sufficiently pertinent to our purpose, it would be interesting to enter into the subject of animal heat in general, and to explain the theory of its production, but we must refrain, and proceed to

speak more fully of the nerves, to which we have only alluded.

4. *Nervous influence.—The nerves* may be called the branches from the central collections of the nervous system, the brain and spinal marrow; neither the central collection nor nerves are found in some of the lower animals and plants; it is true that some observers have thought they had discovered nerves in plants, and others in some of the lowest of the animal tribes, but this must be considered as doubtful at present; it is probable, however, that nerves will be found to exist in many more of the lower animals than can at present be shown to possess them; but it appears to be very doubtful if they will ever be discovered in the lowest of the scale, for their economy does not seem to require a high organization, and the existence of nerves in them may reasonably be questioned; to proceed, we know that if a nerve be cut, or pressed upon, or injured, the part below the injury or obstruction, as it is often called, does not convey its usual influence to the muscle supplied, and the structure is deprived of certain of its properties, as sensation and voluntary motion, which we have seen are vital phenomena, and belong only to living organization.

The nervous centres, as they are called, are especially important for the due performance of vital operations; every one must be aware how dangerous to life any injury to the brain is, if its structure be torn or inflamed, or deprived of proper blood, or pressed, or shaken, its function is destroyed, and life may be destroyed with it; so also, if the spinal marrow, which is a kind of prolongation of

the brain, be affected in a similar manner, life is often destroyed, and if the injury be done to a certain part of the cord, death occurs instantly.

Thus we have briefly mentioned some of the chief conditions which are essential for life; to recapitulate we say, that the necessary conditions are, a cellular structure, a due supply of nutritious and aerated particles, in a fluid state, and a certain amount of heat, as the general conditions; and in higher animals we must add the nervous influence.

Now the circumstances that modify and influence these are, all that destroy the integrity of the cellular tissue, as caustic and such-like agents, and all that deprive the creature of the nutrient fluid, as in drying the plant and polype, and bleeding a higher animal to death or abstracting the supply of blood; in addition to which, as we advance in the scale of life, we have to consider all those that injure or destroy the brain, and spinal marrow, or nerves. We shall have occasion to mention cases in which the various effects produced by disease and accident confirm the facts above given, when we have to consider somewhat more particularly the functions of the nervous system.

C. *The laws that regulate vital phenomena.*— We say laws, though we can scarcely be said to know the laws which regulate these phenomena, so that the processes which we are about to consider should perhaps be looked upon as "facts" rather, and not yet dignified with the name of "laws."

There are certain facts connected with the structural conditions necessary for the manifestation of vital phenomena that are highly interesting, for

they exhibit the action of some kind of controlling power which never ceases, and which ever appears invariable in its progress.

It has often been said that there exists a law of uniformity and one of diversity in reference to animate objects; thus we observe that all are subservient to the general phenomenon of change, involving those of waste and its supply by nutrition, to a state of decline or progress towards death and decay, which is curiously remedied, so to speak, by the origination of new individuals from the objects themselves: so none seem to be at rest like inanimate bodies, but all are impelled through a regular course of action; a particle of organic matter pursues, as it were, a circle, the beginning and the end of which are held together by this invariable power. Again, certain definite and peculiar forms are seen in animate objects, with regard to which both animals and plants may be respectively classified, and distinguished from minerals: thus we find the spheroidal in the lowest orders and in germs; the symmetrical arrangement of parts round an axis, as in the star-fish and flowers of plants; the spiral in many plants, as in the fir cone, and even in the animal body in the fibres of the heart and gullet, and the curious bony structure of the inner ear, called the cochlea, from its resemblance to the snail's shell: then comes, perhaps the most remarkable of all, the bilateral symmetry, where two similar halves are united at what is called the median plane, well exemplified in all the higher animals, and man especially: then the greater proportion are subject to an arrangement of parts, as head, trunk,

and extremities: these extremities again are reducible to one type, as in that of shoulder, arm, forearm, and hand: in plants we see the distinction between the root, the stem, the leaves, and the flower, at the same time their general branching form is composed in a more or less symmetrical manner.

We can perceive, then, that all are governed by what might be called the law of life, which causes them to begin an existence, and continue it by appropriation of matter suitable to form their own bodies; in the case of plants, by the decomposition and assimilation within them of *inorganic* matter; in animals, by a similar use of *organic* matter, so admirably is the balance of the two great divisions of animate objects maintained: these phenomena are referable, according to some, to two forces, *a. metabolic*, controlling the changes in the matter taken as food, and, *b. plastic*, controlling the building up, by selection of particles proper to form the various structures of the body. Then there is the law which regulates forms which may be called *formative;* it is here that we see the tendency to diversity, so evident, indeed, that it is unnecessary to exemplify; but we must not forget that so very many inorganic substances have peculiar forms by which they may be distinguished, which however are reducible chiefly into angular arrangement, very distinct from the curved forms of living bodies. Lastly must be pointed out, the law which destines all living objects to proceed towards maturity, decay, death, and destruction, or dissolution of structure.

Some writers have asserted that the animate world is governed by a law of *transition;* that all are pro-

ceeding from low to high, from the infusoria to man. This view is founded upon the completeness of the "chain of nature," from simple to the most complicated forms of existence, and upon the fact, that the transition states of higher animals in embryo correspond with the perfected forms of lower animals. Thus it is established beyond a doubt, that two such important organs as the heart and brain of man, have to proceed through the forms of the fish, bird, and reptile to reach their final condition; sometimes cases of malformation occur, in which the organ has stopped, as it were, at one of these transition states. The transformation of the leaves of plants into the various parts of the flower, is a remarkable fact of a similar character, and is often attended by malformations, caused by the arresting of the process. Wonderful and inexplicable as all these facts are, we doubt whether they are sufficient to support a theory of transition, because, in examining the earliest trace seen in the germinal disc of the egg, or human ovum, we first observe the rudimentary structure of the vertebral column and nervous system, parts not found in multitudes of lower animals. Again, if this view were correct, we should expect to find transition states in lower animals, in which the very earliest states of the impregnated ovum have been examined; but even in the ovum of the newt and frog, something like the future form of the creature is visible, and nothing like the animals below it in the scale: in nature we never find that more is performed than is actually necessary, so that the simple tube-heart of the human embryo is adopted, as sufficient for the wants of that simple condition of the animal,

the more complex forms being gradually taken on as the more perfected creature required them. Lastly, with regard to this theory, some observers affirm that they have seen the tranformation of animalcules into plants; Bory de St. Vincent, and lately Kützing, assert this occurs in the Ulothrix zonata: this we leave for future investigation.

Another general condition, which appears to be inseparable from the animal economy, is *fatigue*, which, like other states tending to the injury of the individual, is remedied by *rest* and *sleep*, during the performance of which functions, if we may so call them, it is highly probable that the waste of the living body generally, and the expenditure of the nervous energy which has accompanied it, are made up in some mysterious manner, and thereby the living structure becomes renovated; but we must refrain from speculating upon the point, since it is enough for our present purpose that every one can understand what we mean by being "tired," "rested," and "refreshed;" we must remark, however, that the effects of fatigue may be produced by mere *mental* exercise, without any direct *material* expenditure, such as that which occurs in perspiration during violent bodily exercisé, &c.

The phenomena of fatigue and refreshment by sleep are particularly vital, and a certain amount of repose is necessary to all living creatures, especially to animals. A daily state of repose or sleep occurs in plants, and their winter sleep is well known; it corresponds too with the hybernation of some animals. Some writers have thought the idea of

sleep in plants absurd, because they say sleep consists in a cessation of sensation and volition, and the faculty of thinking, caused by want of secretion in the grey matter of the brain and cord, so plants, having no nervous system, cannot sleep.

What, then, is this force that can resist the elements, that seems in a sense immortal,—what its nature? Can we compare it to any other force with whose properties we are acquainted?

D. *The cause of vital phenomena.* Here we approach the limit of our knowledge, and, as usual when we know nothing further concerning a subject, begin to form conjectures and hypotheses; these are quite numerous enough upon this part of physiology: we will, however, endeavour to sketch some of the most important theories upon this subject.

Amongst the philosophers of ancient Greece this was the favourite theme, but we cannot enter fully into all their speculations and ingenious theories, and therefore rest content with stating them concisely. First, it was said by Thales that all things were made of one general substance, *water*, pregnant, however, with vital energy; also, therefore, that all matter was equally possessed of life. The next school of philosophers under Anaximenes taught that *air* was the first principle of all things, on the fact that air is necessary for all things. After this it was supposed that a *peculiar kind* of air, in a very rare and warm state, was the cause of all life, a remarkable approach to the "breath of life" of the Scriptures; Diogenes, the founder of this view, thought that all things which admitted air into their substance were alive, and that air circulating in the blood was the

medium of thought. Heraclitus and others sought to account for all life upon mechanical principles, considering that no life could occur without motion, they endeavoured to show the existence of a physical principle of life; and some thought *fire* must be the cause of life. Gradually their attention was directed towards intellectual causes, when the Pythagorean school arose, which taught that every thing is controlled and actuated by an universal and original spirit, *God*, which they considered, as we do, to be altogether distinct from matter. Nothing can be more surprising than the great progress which was now made; the Pythagoreans not only believed that the soul existed independently of the body, but they distinguished between the life of plants and that of animals, and they divided the soul into two portions, the rational, possessed by man, and the irrational, by brutes; subsequently they discovered that the principle of life and the soul were not the same, and the doctrine of a vital principle or force as the cause of life arose.

The disciples of Pythagoras and Plato first propounded the doctrine, which considers all those phenomena we have been treating of as dependent upon vitality, to be caused by the operation of spiritual "essences," or "innate ideas," which are by them considered to emanate from the Deity, and to exist only in organic and living structures. This doctrine or hypothesis is that which is generally received and believed by religious people and many philosophers, because it admits of the belief, founded on reason, that this innate spirit returns at death to the great originating Spirit from which it emanated at first.

All vital actions are by this doctrine ascribed to the operation of this spirit; its nature is allowed to be altogether distinct from that of matter, inasmuch as it cannot be seen or felt or made in any way appreciable to our senses; its existence and operation independently of matter is believed, because in the vital operations, we see phenomena produced by a force which we cannot perceive but by abstract reasoning, in the same manner as it is believed that electric force acts, although we cannot perceive it.

But all philosophers do not allow the truth of this doctrine: there are many, and their number is increasing, who consider that all matter, of whatever kind, is gifted with this peculiar spiritual essence; they say, "this emanation of divinity inhabits all matter," that "God is in every thing," hence they are called Pantheists; they teach that vitality is a property of matter, as much as form is; that when the proper conditions occur, particles of matter will become an organized being; that at death these conditions have ceased to exist, but that the particles of matter, having formed the being, are restored with all their vitality to the general lap of nature, to become again subject to the conditions that may occur.

These doctrines were taught by the ancient Greeks, with all their wonderful skill and ingenuity, and afterwards by various philosophers, especially by Giordano Bruno, who says, "The soul of the universe fills and illumines the whole world, and instructs nature in the production of genera and species of things in their proper form." "The final end the creative soul has in view," he says, "is universal

perfection, which consists in the development of all possible forms in the different parts and masses of matter;" also, "that the heavenly bodies act with intelligence and design:" "in short, there is one spirit in all things, and no body is so small that it does not contain a portion of the divine essence by which it is animated."

These are the two prevailing theories of life. It is not intended to enter at large into the merits of these; the phenomena of life may be equally well explained by the one and the other, both being hypotheses; yet it will be necessary to mention some of the arguments used by their respective advocates.

The one class of philosophers of whom we have spoken say that "life" is an entity and a substance, not in a material sense, superadded to matter in a state of living organization; the other teaches that life is an essential property of all matter, as much so as form is: both doctrines have in ancient and modern times had many supporters; and the same terms nearly as were used by the ancients to explain the mystery of life, such as "*vital spirit*," and "*vital principle*," are frequently applied in the present day.

The doctrine of innate "ideas," or "spiritual essences," as we have said before, supposes that all organized bodies are actuated by an innate "idea" or essence, said to be an emanation of divinity; this "*idea*" only is permanent, while the organic structure may decay; all the mental and vital phenomena are ascribed to this spirit; at death it is said to return to the divine source whence it originated.

The principal arguments in its favour may be briefly stated to be the following :—

1. When at death life is no more perceptible, it is naturally supposed, since the mind and soul, which all know to be immortal, have fled, that therefore life, which has been destroyed at the same instant, to all appearances, is of a similar nature, and has then returned to its divine source.

2. The properties of matter are known to be wholly of a physical nature, yet in living beings we see the action of a principle apparently distinct from matter, while in death the matter lately inhabited and actuated by life remains the same as regards its physical properties, yet a great change is visible and evident. Such facts are considered impossible, without admitting the doctrine of life as an "entity" or "essence."

3. According to a law of creation, if all the individuals of a species of organic beings are destroyed, the peculiar form and characters of the creature are never restored or recreated from the general store of nature, which would be the case provided all matter were equally endowed with life, and only waiting for the concurrence of chemical and other favouring circumstances, in order to take on the form of a living thing.

4. It is said, that since all organic beings arise from germs, and as the germs of all organic beings are similar, being constituted of a cell and nucleus, therefore the cause of the origin of these, and of the various forms of organic creatures, with their widely differing habits, cannot be found in mere composition of structure and chemical properties such as are

common to all matter, but in an "*idea*" or "*spirit*," resident in the living structure, and implanted at its creation.

5. If life were dependent upon entire structure, how is it that every limb of an animal, and even portions of its body may be cut off, without injury or loss of power and energy to the life of the individual?

6. By way of explaining the theory and offering an analogical argument from natural phenomena, it is said that this "*vital principle*" may be analagous to the electric force, and those called the imponderables.

There appears to have been considerable doubt amongst the advocates of this theory, as to the nature of the *principle*, considered to be additional to structure and matter, as to whether it were a *substance*, or a *mode* only of the living body; this has led to the supposition that it was a subtile fluid analagous to electricity, a view taken by J. Hunter and afterwards by Abernethy. Some, again, thought "life" to be a peculiar substance, unlike any thing else; others, that it is composed of light and electricity.

Many of the upholders of the doctrine of entity or substance of life are materialists, and avail themselves of the opinions of numerous philosophers, who continually endeavoured to prove the entity and substance of life, yet with very different views in every way to those taken by the materialists, the former considering life as of a highly subtile nature and distinct from matter; the latter, as we have said before, holding it to be a property of all matter.

In opposition to the views in favour of a vital principle, above stated,

1. It is held that an organic creature lives by virtue of its peculiar determinate composition and structure; that life is the result of certain peculiar conditions which compel it to manifest itself; and when death occurs, these conditions are destroyed, and life is no longer possible, although the matter itself still retains the universal life of nature, and will become ready, in its turn, to perform the duties of a living organism, whenever the proper conditions are fulfilled.

2. By this theory vital action is explained without the aid of an imponderable and subtile principle; for the term "life" is then an abstract term applied to the concurrence of certain peculiar conditions, which may be produced or destroyed at any time.

3. With regard to the destruction and loss of particular genera and species of living beings, it may be said that the necessary conditions for producing these have not occurred again.

4. In answer to the question, how can organism be set up by chemical or mechanical forces? it is allowed, that this cannot be accomplished but by life; nevertheless, life is held to be simply the result of the peculiar conditions of structure. In chemistry conditions somewhat analagous to these are not uncommon, where several substances conspire, as it were, to produce changes, when only one is decomposed or altered in its nature.

5. There are no reasons for concluding that life, whatever its nature may be, is a whole that may be weakened by the subtracting of a part, provided the

parts that remain possess all the requisite conditions, when life is not lost; if those that are taken away do not possess these conditions, life is not exhibited in them: if, however, a simple animal, containing in every portion of its structure the materials for these conditions, be divided even into more than two parts, each of them will retain the vital properties, and continue to live as a separate being.

6. That electricity applied to certain of the living structures produces actions similar to living actions no one will deny, but some have sought to prove that these forces are identical; if this were true, it would follow that organic particles submitted to electricity would become living particles, which we know is not the case.

Moreover, it is well known that the application of the electrical stimulus tends to destroy life and irritability. Some have tried to prove that the functions of the animal frame might be produced by galvanism, and Dutrochet declares that he has formed muscular fibre by galvanising serum; but in the first case, it is questionable whether mere mechanical irritation of the nerves of the stomach immediately after death would not have produced equally true results, and the second is scarcely worthy of serious discussion.

In modern times another view has arisen, differing from either of those above referred to, which tends to show that what is spoken of as "life" is neither a property of all matter, nor a substance in itself, but a nonentity. The upholders of this doctrine would say, that the term "*life*" is an abstract one, having reference to the sum of the living actions

in organized structure; thus, that where you have certain proper and peculiar conditions of structure and organism, there you find life: that when these cease or are destroyed, life is no longer manifested. This doctrine is in effect similar to that of the Pantheists, though it differs widely from that as regards the existence of the property of life in all matter, which it does not maintain. The followers of this doctrine, or the nonentity school, as they may be called, would not, we imagine, wish to be considered materialists, neither are they, so far as the most important part of that doctrine is concerned; for while the materialists make their views apply to mind as well as life, the nonentity men do not deny the spiritual nature of the mind or human spirit, but believe in the immortality of the soul.

Having thus given a general view of the doctrines concerning life and organism, or the cosmological systems, as they are called sometimes, we purpose taking a general view of the whole subject, by way of recapitulation, and for the sake of enabling the reader to form a clear idea of the different doctrines.

When all that can be said in explanation of phenomena must be hypothesis, and when all the hypotheses offered are equally sufficient to account for and explain the facts, it becomes a very difficult thing to pronounce as to the correctness of one or the other. The subject of the different hypotheses under consideration is unfortunately so mysterious and difficult to handle by the modes of philosophical investigation, that we are ready almost to despair of ever arriving at the truth; at the same time, seeing how closely analagous are the phenomena of life and

those of mind, with which the soul is all but identified, we cannot help feeling anxious lest any doctrine offered by the writer should offend the prejudices and belief of well-meaning persons: all tends to render arduous the attempt to direct the reader's thoughts upon the subject, so that he may take a view of the theory of life, correct, as far as science can lead, and not incompatible with his prejudices and belief, as a creature of divine origin, and of moral and religious obligations.

The great Bacon says, "Hypotheses non fingo," &c.; and again, Newton, "Causas rerum naturalium, non plures admitti debere, quam quæ et veræ sint, et earum phænomenis explicandis sufficiant." The words of these great masters in modern philosophy should be our guide; and if we are compelled reluctantly to adopt any hypothesis, let us be careful how we rely upon one that requires the operation of a new cause, something indescribable and imperceptible, the effects only of which can be appreciated, which effects being wanting, there is then no evidence as to the cause. On the other hand, if certain phenomena can be explained by known laws, and by the effect of known causes operating generally, and without the supposition of some new agent, then it behoves us rather to incline towards such a mode of explanation. In proportion as one hypothesis involves the supposition of one or more ulterior hypotheses, so ought we to suspect its truth and foundation.

Until it is possible for human intellect to comprehend the power and design of the Creator, it is vain, if not presumptuous, to speculate upon the

manner in which creation of matter, and its conversion into the varied forms of this earth, were and are accomplished. The origin of matter is a mystery; the result of the great command, "Let there be light," is likewise incomprehensible to finite minds; doubtless it was preceded or accompanied by some stupendous atmospheric change, not less inexplicable or wonderful. The creative act compels the dead and shapeless earth to produce the varied forms of vegetation, each blossoming and "yielding seed after its kind;" the waters, "gathered together," bring forth the fishes and fowls of the air; while from the earth again arise the other animals, excelling those created before them, in the complication of their bodies, and the perfection of their organization; lastly, from the same source, we are told, sprang man, the most complicated, the most perfected, and the most highly endowed of all, "made after God's own image."

But the earth itself is no longer "without form" nor "void;" its rocks, its minerals, its stalactites, its crystals, whence do they arise? what impulse or energy causes their peculiar and numerous shapes? What can we answer, but that they obey the great mandate of creation, and are the results of power, will, and design? That the peculiar forms of minerals and crystals may yet be accounted for by known causes, let us not pretend to deny; but it remains to be told how those causes themselves arose, an enquiry which still leads us to creation.

When we compare the form of the lowest vegetables, such as lichens and fuci, with crystals, how remarkable is the resemblance between them! each

consists of a simple branching form, a very simple structure, growing upon a rock, which each seem to require as a sort of starting point—a point d' appui. It is true, the simple plant lives upon the air, moisture, light, and heat, and perhaps electricity around it; but who is to say that the crystal may not do the same, and be similarly dependent upon these agents? Every one must have observed in frosty weather the depositions of watery vapour upon a cold surface, such as a pane of glass, and the beautiful crystals shooting in such graceful forms, as if impelled by vitality itself. Again, we see one of the lowest in the animal scale, a sponge or coralline, fastened to a rock, without selection or choice, there to remain and increase by the mere contact of the matters around it: when taken from its habitation, it exhibits no more change than a crystal would. So also some kinds of polype, in regard to their form, are scarcely to be distinguished from plants, and resemble them closely, too, in being propagated by shoots. Certain circumstances are necessary to the formation of these creatures; so it is with crystals, some cannot be formed without air, light, heat, &c., and their formation is known to be much favoured by galvanic currents.

We make these remarks in order to point out the completeness of the chain of nature, to show that if we please we may lead our thoughts from the highest animals down to rude matter, from which we believe all created objects sprang: "Natura non facit saltum."

It may be said, is not this lowering the mystery of life too much, and speaking of the creation of

living things as of no marvel, but merely as the result of natural causes? We answer, no, for though we may be able to explain "life" by known causes, yet still the mystery involving the origin of those causes remains untold.

Are the revolutions of the planets, the rising of the tides, the source of light and heat, the constitution of the atmosphere, less wonderful than the phenomena of life? surely not. Are we not compelled to imagine the existence and operation of subtile fluids or ethers as the causes of these phenomena? Is not the same course pursued with regard to "*life*," and do we not comprehend the one set of phenomena as well as the other, while the laws which regulate both are almost equally well understood?

The creation of the antecedents to life is, if possible, more wonderful than the phenomena of life itself, and cannot the less impress us with that veneration and profound awe which become us as created beings, gifted with a power of thus far comprehending such mysteries.

Now we have already seen that *some philosophers explain organism or life, as they would other phenomena of nature, by the operating of known causes*, attributing the phenomena of life and organization to the peculiar mode of combination of elements. It is not necessary to mention the names of the celebrated supporters of this theory, it is sufficient to have stated it; it explains all the varied forms of organized bodies, by differences in the mode of combination of their elements, whereas it is well known that form does not determine the mode of action or

quality of bodies, for we may have what the chemists call isomorphous bodies, which have different properties, and we may have the same properties possessed by the same body in two different forms; thus we find that the arseniate of soda, a highly poisonous salt, possesses precisely the same form as the phosphate of soda, a comparatively harmless substance; the composition of the two being precisely analogous, as seen by their formula, ($2\,\dot{Na}\,\dot{H}\,\ddot{A}s+24\,\dot{H}$) and ($2\,\dot{Na}\,\dot{H}\,\ddot{P}+24\,\dot{H}$); there is another salt, containing 14 atoms of water, which has a totally different form, but still the same in both compounds; all the alums, too, are isomorphous: there are examples also of a substance remaining the same, so far as we are able to detect its composition, but altered in its form and appearance; *e. g.* Iodide of mercury, when first sublimed, is of a bright yellow colour, but becomes a fine scarlet when cool; sulphate of manganese may be either in pink or white crystals; the diamond is precisely the same in composition as common charcoal, so the brilliant calc-spar is simply chalk. These facts are very curious, and lead us to think that some change has occurred which we cannot yet appreciate; some suppose that a change in the amount of specific or combined heat has been effected. Further, the *germs* of all animals are similar in form and structure, yet the difference in their properties is very great.

It is said, "that immediately after death, the elementary composition of organized bodies does not appear to be different from that of bodies still living;" therefore it is insisted, that we must admit the existence and operation of a principle not recog-

nizable by chemical analysis, whether it be "as an imponderable matter or a force or energy."

But it may be questioned if our powers of chemical analysis are yet so far advanced as to detect minute differences in organic bodies; in fact, it would seem that the more advanced the department of organic chemistry becomes, the more are we enabled to perceive and treat of subtile differences hitherto unknown; besides, one great characteristic of organic substances, as stated in a former part of this essay, is, that although composed of the same elements common to all matter, yet they are different in form, appearance, and proportions; and the remarkable difference in the constitution of some chemical substances, or, so to speak, in the arrangement of their elements, shows that subtile and inexplicable changes, relating to the properties and qualities of inorganic bodies, do occur, although their constituents and form remain the same; therefore we are not yet in a condition to deny the occurrence of change in the elemental arrangement of organized bodies at death, or change in their material properties.

The doctrine of "vital principle" or "organic force" admits that life depends on organized structure and necessary elementary combination, but allows that the vital principle may be "*quiescent*," a state not to be confounded with death nor life, but to be considered as "a capability of living," a "*potentiality*" of life; the life itself is said to begin under the influence of certain necessary conditions, such as heat, air, water, and nutriment or organic matter, and these are necessary to its continuance;

the germ, however, only remains quiescent, or exhibits no life, so long as it is maintained perfectly beyond the influence of external agencies.—*Müller.*

But what is the state of the structure during this quiescent state; is it not complete and perfect as when first the germ itself was formed; and doubtless possesses the same properties and qualities; but it remains to be said, that if the structure be injured, or its elements act upon each other, from any cause, its properties are destroyed, and certain products are the result, just as if any crystal had suffered decomposition. We do not mean to say that the properties of the germ were merely chemical, nor that its structure held within it any principle identical with the chemical force or any of the imponderables, but we must confess there seems no necessity for imagining the hypothesis of a subtile spirit to explain such phenomena; certain changes occur in a given structure under certain circumstances, and without those conditions they do not exist.

Stahl considered the "rational soul" itself the primum movens of organization; that the soul preserves its body, and by its organic action diseases are cured; he places the manifestations of the soul combined with consciousness on a level with the organizing principle, the operations of which, though in accordance with design, obey regular laws; but the organizing principle is not resident in any particular organ as the mind is; it acts in anencephalous monsters, and even modifies the nerves and nervous centres of various animals, as in the transformation of insects or batrachian reptiles.—*See Müller*, p. 24, Vol. I.

It may be fairly asked, what need is there of any fresh hypothesis? for in studying this phenomenon we are acquainted with as much as satisfies us in the consideration of any of the ordinary chemical and mechanical phenomena: we say in chemistry that certain phenomena are due to endosmosis, *e. g.* if a vessel containing hydrogen be placed above another full of carbonic acid, the heaviest gas, and these allowed to communicate by means of an opening, stopped, however, with dried pipe-clay, we shall, in a very short time, find the heavy gas has passed through the porous medium into the lighter and upper gas; this may be called attraction, but it is no more capable of explanation than the fact that the carbonic acid escapes through the membrane of the lungs, and is thus expired: again, if a bladder containing a small portion of air be passed into a jar of carbonic acid gas, it soon becomes so distended by the penetration of the gas as to burst; analogous effects occur between liquids of different kinds. We know that if an acid be added to an alkali, an action occurs, and a different substance is formed; so if water be cooled to a certain degree, an action commences, and its form is changed. These things can no more be explained than the effect of air, &c. upon the germ; we are unable to say what the principle is which actuates the acid and the alkali, no one has yet detected any force; it is true we say it is due to chemical affinity, but what is this affinity? We know of it only by its effects; some say it is electricity, others caloric, others a universal ether, others something sui generis, so that all is hypothesis, as in the phenomena of the germ, though the laws which regulate both are equally well understood.

Having said thus much as to the simplest forms of vitality as seen in the lowest animals, and the germ of living beings, let us now refer briefly *to the vital conditions necessary for the developed organism*, the state opposite to that of the germ, and one that at once involves the principle of living and the continuance of life.

Here again we find that external agents are necessary; caloric, water, atmospheric air, organic matter, maintain life, inducing "constant changes in the composition of the organized body, and combining with the body, while certain old components are again decomposed and cast off."—*Müller*. We have before seen that the blood is a necessary vital stimulus; this fluid having undergone the necessary changes by the action of the agents just spoken of, becomes fit and qualified to stimulate the organs of the body, "producing in them organic change of composition essential to the manifestation of life:" and again, "the vital actions themselves are attended with decomposition of organic matter; the pupæ of insects, when in the crysalis state, and taking no nourishment, afford excrementitious matter."—*Id.*

These are the words of one of the greatest modern physiologists, who teaches the doctrine of a vital principle;—it will be observed, that this account speaks of "material changes, by which the essential elementary combinations are maintained, and the phenomena of life are produced:" if such things are evidently the causes of excitability, why do we need the "vital principle," what has it to do? and it is clear that the author is not quite satisfied with

his own views, for he says, "I say that the name stimulus, vital stimulus, gives an empty and indeed false notion, unless the material changes, the constant new combinations and decompositions of ponderable and imponderable matters induced by it be at the same time remembered."

But there is a chemical action called catalysis, which is very remarkable, especially as it appears to be much concerned in organic changes; it is, however, merely a fictional name for the kind of phenomena, and affords no clue to the real cause of them, which is at present mysterious: the simplest example is that of the action of yeast in producing fermentation, the yeast causing the sugar to be converted into carbonic acid and alcohol, remaining itself unchanged: so a mixture of hydrogen and oxygen gases may be even heated without forming any combination, but if a piece of platinum be placed in them, they immediately unite, forming water, while, if sufficient in quantity, the metal becomes red hot, and explodes the whole, although it remains perfectly unchanged itself; the common spirit lamp, containing a ball of platinum constantly at a red heat, acts in the same way, the spirit being converted into its elements by the presence of platinum: the peroxide of hydrogen is instantly decomposed if almost any substance is allowed to come in contact with it, yet the substance causing the action remains without the slightest change. One more example from organic bodies; an acid converts a solution of starch into gum and sugar, although no change takes place in the acid, for it remains free and undiminished; the parallel to this in the living organism is seen

in the action of the vegetable principle, *Diastase*, in the germination of seeds; it converts their starch into gum and sugar, which, being soluble, flow in the sap and nourish the plant: it is to an action of this kind that the favourers of the chemical theory would ascribe the phenomena of life which we have described, and if such actions are proved to exist in plants, we do not see why corresponding processes in the animal economy should not be similarly explained. We may remark, that there is sufficient evidence of an action equivalent to the chemical when simple contact takes place between two different substances; galvanic piles have been made of various materials, amongst others with alternate layers of muscle, fat, and membrane: the facts of thermo-electricity show the effect of heat in setting up a new state, and lately it is asserted that chemical decomposition of water has been effected by a current of heat alone: connected with these facts, we must remember the necessity which we have seen exists in the animate economy for the bringing together of *different substances* under a certain degree of *heat*.

The importance of the nervous influence has been before stated: we must remind the reader also of the effect of light on animals, and the necessity of it for plants.

Thus far we have endeavoured to point out the great importance of elementary combination and material changes to the manifestation of the general phenomena of life; we have also shown that these may be accounted for on rational and known proximate causes, therefore we submit that it is better to incline towards such a mode of explanation, as being more

conducive to experiment and more free from hypothesis, than the doctrine which requires us to imagine the operation of a vital principle as the cause of such changes and the manifestation of such properties as those which constitute the characteristics of organized bodies. Many people are so bigoted to the old Pythagorean notion of life being an emanation from the Deity, by the "breathing into the nostrils the breath of life," doubtless the language of metaphor, that they think it almost sacrilegious, or at any rate materialistical, to attempt even the application of principles of mechanics and chemistry to explain the vital phenomena; they would prefer leaving all in awful mystery, with a sort of vague feeling of veneration for the Almighty power; but enough has been said to show that such sentiments are erroneous, and that although we should eventually be able to explain vitality, we should only be perceiving the universality of certain laws, the origin of which would be as much mysterious as ever; and then the explanation of the mental and intellectual life lies before us.

But it must not be supposed that in saying this we mean to deny the utility and efficacy of vital organization; it cannot be said that such changes as those we have just referred to could be produced without the aid of organism, but the force or property of organism itself may be peculiar and different from that which impels the interchange and combinations of external stimuli with the matter of organic structure, without being an "*ether*" or "*spirit*," a "*vital principle*" or "πνευμα:" the nonentity school assert that there is no such thing

as a vital principle, and they say the onus probandi rests with the entity men; this is both fair and philosophical.

Good examples of the effect of the living organism are seen in the conversion of the food into a pulp by digestion in the stomach, and subsequently into a different substance, approaching the blood in character, in the small intestines: again, by means of a delicate but sure test, we are able to detect that during digestion the inner coat of the stomach is in one state of electricity, while the blood, leaving the organ on its external surface, is in another state. The experiments of M. Matteuci would show that the bare muscles of an animal, during life, placed against the exposed nerve of another, also alive, or stunned, produce muscular contractions: the wonderful power of the Torpedo is found to be dependent entirely upon its life, and is proportioned to its state of health and strength, for it will kill itself if made to give repeated shocks.

The doctrine which explains vital phenomena without the operation of a vital principle suffices very well to explain all the lower modes of life, but when we ascend the scale of living beings to those animals possessing sensation, voluntary motion, and consciousness, it must be allowed some difficulties arise, for we cannot conceive how the varied and complicated muscular movements of these creatures, their senses, and their mental and instinctive faculties, can possibly be caused by the most refined chemical and mechanical actions: perhaps none but the most determined materialists would uphold such

a view; certainly most of those who deny the operation and existence of a vital principle do not maintain such an opinion.

The great importance of the *nervous influence*, as it is called, for maintaining the functions and life of the higher animals, is allowed by all physiologists; some seeing that irritability consists in the manifestation of "certain movements, molecular or sensible," and that muscular fibre and nerves are necessary to these, have therefore argued that the nervous and muscular systems are the seat of irritability.

Müller says, speaking of "life," *i. e.* the vital principle, "the mobility of this principle is certain; this passage of the vital principle from one part to another is seen still more clearly on the removal of pressure from a *nerve* after that state has been produced in which the limb is said to be *asleep;*"—and again, "the nerves effect important material changes in the organs, and their active force, probably an imponderable agent, is an important internal vital stimulus."

We have before spoken briefly concerning the influence of the nerves; it is not our intention at this place to enter at length upon the subject of sensation and voluntary motion and consciousness, nor the discussion of the nature of the nervous energy, but we wish to caution the reader against taking for granted these views concerning the nervous influence in connection with life and the "organic force;" it might be thought that the seat of the supposed vital principle was discovered to be in

the nerves, which would be very erroneous. Müller's example is a fallacy, for the life of the part asleep is not destroyed; its sensibility and its susceptibility to voluntary controul are suspended, because the trunk of the nerve supplying it has been pressed upon; but if this pressure had been continued for a sufficient length of time to destroy the continuity of the nerve, and consequently the nervous influence over the limb, yet the *life* of the limb would remain, the part would not die and become disorganized. However, though not inclined to look upon the nervous system as the source and channel of life, nor as the proper seat of irritability or vitality, yet we must admit that the nervous influence is an important element of vitality, perhaps the most important; certainly the amount of vital manifestation in a part deprived of the nervous influence is much inferior to that in a perfect and healthy structure, but nevertheless vitality of the tissues does remain, although they may have decreased in bulk and become altered and deteriorated in properties; it is worthy of remark, that structures thus impaired have a tendency to change into cellular tissue the simplest form of living structure. The vitality of polypes and other animals low in the scale, although of inferior character, is not the less active and vigorous, and this probably without the influence of nerves.

In the highly developed organism the relation and mutual dependence of parts upon one another, as well as upon the integrity of the whole, prepares us to expect that so extensive a system, one so protected and so carefully supplied with blood as the nervous

system, must be of vital importance; this is borne out by facts met with constantly in medical practice. Injuries to the central parts of the nervous system, the brain and cord, are attended, either immediately or in process of time, with serious effects, and even death; however, with regard to these it may be questioned how far the injury done to the brain or cord is the direct cause of death, because, from the failure of respiration, and with it the circulation of aerated nutritious particles, the structures are deprived of a most important stimulus, the blood. The converse to the case of direct injury to the central nervous collections is also found to be attended often with the same instantaneous results, *e. g.* if the heart from any lesion of its structure cease to act, death as suddenly occurs as if an injury had been done to those parts of the nervous system concerned in respiration: so if the supply of blood to a part be cut off, death speedily follows, although the nerves shall have been left entire.

With regard to the blood, considered as a stimulus of life, we must be careful how far we admit its influence in vital actions, for some physiologists have erroneously thought this fluid was possessed of life; we can easily allow that it is an organic fluid possessed of properties elementary of life, but it is no more alive than the atmosphere, which is equally necessary to life.

The constitution of the lymph, chyle, and blood has of late been so well made out, that we will give a short description of these fluids which circulate in the animal body: they all "consist of a liquid holding small particles in suspension;" the size of these

globules varies in different animals; those of the blood are larger in birds than in mammalia, and largest in the Proteus ($\frac{1}{400}$ of an inch) a species of lizard, smallest in the musk deer, in which they are only the $\frac{1}{12000}$ of an inch. Mr. Gulliver thinks that there is a relation between their size and that of the animals in those of the same order. The form varies in many ways; in man they resemble a piece of money with a dent on each side, and measure from $\frac{1}{3500}$ to $\frac{1}{2200}$ of an inch; the same form prevails in mammalia, except in the camel tribe, where they are oval, as in birds, reptiles, and fishes; in some, as the scorpion, they have a rim of granules, and in others are somewhat like a raspberry.

These fluids, when taken from the body, undergo certain changes; in the blood every one is familiar with the coagulation; a similar thing is seen in the other two fluids, but on minute inspection it is found that the blood corpuscles first become jagged at the edges, and sometimes take the shape of a half moon, and what is most curious, they run together by their flat surfaces, and form a rude net-work of irregular columns in the clot, like rolls of money; in a few moments, however, an oscillating motion is seen, and these become broken up, and the globules disunited; the nature of this kind of attraction is not known. Hunter thought that the blood coagulated by attraction of cohesion, and then became dead, but this is not admitted, for we know it then becomes the first matter organized in the healing of wounds. Many circumstances influence this process; we shall only mention that effused blood kept in the living tissues is found to remain fluid for a very long

time; this has been attributed by some to the vitality of the tissues: it has been discovered, that in inflammatory blood the mesh-work of rolls of globules is formed more rapidly, and is of a closer texture: it is found also, that woman's blood coagulates two minutes sooner than man's: most fluids, in becoming solid, give out their latent heat, but the blood does not yield any. Transfusion of blood from one person to another has been used to recover patients dying from loss of blood, but not successfully; it is remarkable also, that if the blood of a mammal be injected into the vessels of a bird, death follows instantly.

Now these facts are not accounted for by chemistry, though some think that coagulation is caused by chemical agents, as that of milk by rennet; others prefer the vitality view, and think it may be stimulated to coagulate like a muscle to contract; others say, that when in the body it is the subject of vital repulsion, but when drawn out that vital attraction acts: for our part, we are disposed to think the blood retains some property after it is taken from the body, neither chemical nor mechanical, to which coagulation is attributable; just as we see that irritability remains after death, as proved by the effects of galvanism and other stimuli upon the muscles; still it must be stated, that if it depends on vitality, this property may apparently be preserved, for it is found that fresh blood, to which salt has been added, will remain fluid for a year and a half, when, if water be added, it exhibits all the phenomena of coagulation we have described.

It appears then that we are unable to identify the

principle of life, if there be such a thing, and we cannot show that any particular structure or fluid of the body is the seat of vitality in preference to any other, so far as our present means of investigation avail; the question as to the existence or not of a vital principle may be allowed to stand over until we possess the means of testing so subtile and evanescent a substance; in the mean time, however, since all that can be said in support of the vital principle theory is but hypothesis, we are called upon to uphold such doctrines only as are founded upon rational and obvious causes.

We have failed to show that the phenomena of life depend upon chemical composition, mechanical arrangement, or chemical constitution; and we have not been able to prove that life is supported by the nervous influence in particular, or that it is identical with that influence; neither could we allow that the blood alone, although seen to be so necessary to life, can constitute life or is itself alive: there are no reasons for believing that the air, heat, light, and electricity are in any superior measure the vehicles of life, or themselves identical with it. On the other hand, we have not been able to admit the existence and operation of some new imponderable and inappreciable principle, something superadded to matter, so constantly called "the vital principle," and to which every phenomenon of mystery in physiology has been by some ascribed.

But in studying the vital phenomena we are inclined to think that too much attention has been paid to one set of phenomena, to the neglect of the whole group; we suggest that the combined or con-

joined operation of the elements which constitute living organism is most important; that in this rests the secret of life; not in the nervous influence, the blood, the muscular tissue, or in the operation of an unknown "vital principle;" we know the importance of this union of structures and functions, for if only one be left out the phenomena are deranged, and life may be destroyed. We venture to think, that if the study of vital organism as a whole, assisted as it may be now by the very advanced state of the physiological and chemical sciences, will yet lead to a better understanding of the phenomena of life.

PART II.—MIND.

INTRODUCTION.

The Action of such a principle as Mind and Intellect inferred from the consideration of the laws of the vital economy; Superiority of human mind, and quality of recording its actions; Endowment of the Intellect with progressive power.

In the preceding division of our subject we paid some attention to the phenomena that may be studied in connection with matter, whether animate or inanimate; we saw that certain necessary conditions exist, in which the various phenomena occur, and that certain "*laws*" are in operation which we say regulate the occurrence of these conditions and the accompanying phenomena: we have observed also, that a general scale of life exists, and that animate objects may be classified accordingly; the same may be done with inanimate objects, for they have their relations, and are classified according to them; this is often called a system—the system of the universe.

But the idea or conception of different kinds of things, having certain general relations to one another, yet so different as to admit of classification according to those differences, is remarkable, inasmuch as from what we have seen of organism and vitality, as well as of material forces, we cannot admit either to be the *cause* of these differences; we cannot allow that the conception and setting up of "genera" and "species" could originate by "*life*" alone; we know, from observation of our own race,

that none but the highest organized condition combined with a superior mind, as we say, can sustain the idea of genus and species, and that to entertain fully the idea of a "law," requires still higher kind of thought, as well as a cultivated intellect; the most refined and tutored intellect is constantly searching for "laws," and is gratified either by the discovery or the comprehension of one: if, then, it be admitted that it requires the exercise of a peculiar property to conceive and frame a law, and that certain laws have been known to be in operation, it follows that the laws themselves, as well as the conditions exhibiting them, which may be said to be the result of their action, must have been *designed*, and that the *conception* of the laws must have existed previously: this may be rendered plain by attending for a moment to the action which occurs in our own minds, *e.g.* I intend to place my hand on this book—the will to do this is one thing, the act is another, and the will must occur first; for it would be absurd to place my hand on the book, and then to will to place my hand on the book;—this "will" as we call it, then, is the "cause" of my act.

Speaking of forms of nature and art, Harris says, "'Tis in mind they first exist, before matter can receive them; 'tis from mind, when they adorn matter, that they primarily proceed; so that, whether we contemplate the works of art, or the more excellent works of nature, all that we look at as beautiful, or listen to as harmonious, is the genuine effluence or emanation of mind." To return, the "idea" of a universe and the laws to regulate it, must have existed first, and is often spoken

of as the "cause," "the great first cause before the world was:" its original or previous existence being allowed, we must therefore admit its independence or possible isolated operation; again, if there be any "cause," it must necessarily be different from the "effect," this is an absolute truth; to the study of this cause we wish particularly to excite the reader's attention.

Thus we arrive at something different from all that we have before spoken about, a "force" which consists in the origination of an "idea," and the power and disposition to work out that idea, called "will" and "design;" every man knows that by the action of this force all things in our economy are performed; we are conscious of such an operation in our own thoughts, we perceive its operation in the actions and motives of others, we therefore naturally conclude that all we are sensible of is the result of the operation of this force, we call it "*mind.*"

It might be desirable to enter into arguments to prove that all phenomena are the result of "design," but did our limits permit, this would be scarcely requisite, seeing how ably it has been done by many writers.

We must consider the first great cause to be essentially "mind," and that all mental existences we are in contact with are similar in nature, and, figuratively speaking, as it were reflected points from the grand light of the original mind, or, as it has been said, "emanations" from the Deity; all mankind believe this; the rudest savage, worn out with bodily pains and mental miseries, prays to "the great Spirit" to relieve him and longs for the time

when his *spirit* shall be set free from all troubles, and return to the company of the great Spirit; the intellectual man, seeking to penetrate the grand mystery, soars to the limit of our finite thoughts, longing to pass the barrier, and realize the thoughts of immortality.

When the stupendous miracle of the creation occurred, the light of mind shone upon our earth, with this came life and all its mysteries; preceding it had been set up all the phenomena and laws of the material world; here are three remarkable conditions that have been in existence and operation during this time—the πνευμα, ψυχη, and σωμα of the ancients: the operations of the first are inexplicable, and conceivable only: but those of the second, although they are equally inexplicable, yet are endowed with the power of recording and communicating their action, while the material world has continued as it began.

With regard to the mental force there is this peculiarity, its power, so far from diminishing, may be said to increase, inasmuch as the labours of the mind may be carried on from any point of ceasing by another mind, and a record left which is still available to others; so that what is death and destruction to "life" and "organization" is not so to "mind."

MENTAL PHENOMENA.

A. Of mental phenomena in general.—In entering upon the description of these it is to be understood that we intend to consider all phenomena that appear to be the result of the action of such a force as we have just been endeavouring to point out: in speaking of the instinctive acts of the lower animals we shall meet with some difficulties, but hope to be able to render plain what is understood by mental phenomena, as distinct from any others that may be studied.

Certain forces exist, which cannot be seen or appreciated but by means of the effects they produce, the cause and its nature remaining hidden from our senses. We know this to be the case in various phenomena of the natural world, which need not be again described. We have seen that there are powerful arguments advanced by some philosophers for considering the vital phenomena as the effects of a force somewhat similar in its nature, inasmuch as its effects and circumstances only can be studied; now we have to study the phenomena of another force, which, if possible, is still more out of the reach of our senses, and in the importance of its actions transcends all others.

The manifestations of mind may be observed and proved to exist in a very large proportion of the animal creation, and perhaps by closer attention the

mental force may be found to be acting in all; the lowest class of animals exhibit psychical signs; as we advance in the scale, these take on a more complicated character, and even approach those seen in man, so that "*mind*" must be admitted as one of their properties; at the same time we must remark, that the mind of man and that of animals is widely different, as we shall show when speaking of the classification of mental phenomena.

The processes going on in the human body and in lower animals, which are purely the result of organism, and dependent upon "life," are not subject to the "will," no caprice of the animal can act upon them; they proceed independently of any but a vital impulse; but there are other processes or phenomena, which, although equally dependent upon vitality and its conditions, yet are not caused and produced by life, but by the energy of "*mind*." The processes of digestion, respiration, circulation, nutrition, growth, &c., go on by the *vital* stimulus alone, but the *locomotion* of the body by the muscles cannot be produced without the operation of a *mental* force; thus we say that the "will" controuls these motions and produces them. Voluntary muscular action is *an instance of the simplest mental phenomenon*, and may be seen in nearly all animals.

When we compare certain movements seen in plants, as referred to in the preceding part, there may seem to be some analogy between such motions and those of the lowest animals, and the phenomena in both cases are considerably mysterious; the climbing of a plant, and the planting and fixing of its hooks to support its weight, exhibit as much design and will

on the part of the living structure, as the prehension of food by accidental contact seen in the polype and actinia; so that it must be admitted that the phenomena of vegetative life and those of the lowest instinctive animal life are so closely allied, that at present we cannot pretend to decide which are voluntary and which not; but if we ascend the scale to some of the highest amongst instinctive instances, as the bee, we find that a corresponding precision and formality is exhibited in the building of its cell, equally as in the expansion of a flower and the climbing of a plant, yet there is this difference between the acts,—in the *animal*, a stimulus or impulse from within, and the property of the animal, acts, while in the motions of plants the stimulus is from without, and not the property of the organism; still it may be said that both are endowed with the quality of life, and to both the stimulus of the air, nutriment, heat, and light is necessary; indeed, the difficulty of distinctly characterising and classifying these objects, according to their psychical properties, must be admitted. The movement of the leaf of Hedysarum gyrans, before spoken of, occurs independently of all stimulus and is incessant, the two portions of the leaf, one on each side of the midriff, continually approaching and separating like fans, and with some force.

However, there are certain other phenomena that effectually distinguish the acts of the inferior animals from any thing vegetative; the lower animal has powers of locomotion in a full sense, in which, as we have before said, consists the action of a "*will*," for the locomotive *movements* of an animal

are not performed with that blind impulse that some other acts of its life are, being regulated according to circumstances; if the animal is opposed in its progress, it avoids the opposition by efforts almost exhibiting reason, varied to meet the occasion, and often varying under the same circumstances. The different kinds of motion, in leaps, gyrations, oscillations, and leech-like attitudes, are not seen in the moving plants; the combats of the infusory animalcules, and the expedients resorted to by many insects to obviate difficulties, must be admitted as of a mental character, and very superior to any thing seen in plants. In speaking of these points, it may be remarked, that mind has been denied to many of the lower animals, who do really exhibit its manifestations; however, Mr. S. Turner boldly speaks of the *mind* of many of the lower animals, and apparently with great justice and utility. *See Sac. Hist. of World.*

Such phenomena as we have been treating of, viz. *locomotion* guided by the will, and other acts connected with *self-preservation*, &c., are essentially psychical, although we shall hereafter point out the difference between the simply mental and the more intellectual of such phenomena, and refer also to the distinctions between the minds of brutes and man.

Before proceeding to discuss mental phenomena, we will endeavour briefly to point out *the differences between vital and mental phenomena*, by which means we shall render clearer the properties of the mental force.

We have admitted that there is a great resemblance between these two kinds of phenomena, but

the differences are evident enough. 1st. *When an object is presented to a sentient animal*, it gives rise to certain ideas in the mind, or we may be conscious of certain images that arise from the perception of the object; now this is a mental phenomenon, and there is no sort of reason why we should admit the origination of any such image or "idea" from an object presented to *a plant*, not only because there is no evidence of any such action, as in the efforts to avoid injury, the shrinking and cries of pain, and such like, seen in animals possessed of sensation and voluntary power, but also because there appears no necessity for the functions of relation, as they are called, in plants. 2nd. To take the instance from man, when the impression from a *number* of *objects* is presented to the sensorium, the qualities of each are perceived, the idea of each object is set up in the consciousness of the sensorium; the points of resemblance and difference between these "ideas" are also perceived, and a *general* quality is seen to be common to all; thus the idea of generality arises, called a "general idea." Even more than one general idea may be formed at the same time; they may be compared, and a result produced, in which consists the highest kind of intellectual action; it need scarcely be said that nothing of this kind occurs either in plants, the inferior animals, or indeed in any but man himself.

3rd. In the operations described in the first division of our subject, the organizing force renders itself evident by operations that may be seen, and "realizes the type of its operations in a material form," in fact, by "phenomena;" whereas the men-

tal force does not exhibit itself by any material form, and hence its operations have been called "*noumena*," as arising in thought and consciousness only. In connection with this character of the mental force we may observe, that although the tendrils of a plant coil round any object suited to support it, in a manner similar to a willing being, and though the sensitive plant shrink from the touch as if it felt pain, yet these phenomena are produced by the action of a *foreign* stimulus: so the offshoots of a potatoe kept in a dark cellar will creep, as if by design, towards the light and fresh air, or the roots of a plant shall, as it were, seek out the water near them, or the branches of a tree, in a crowded grove, shall bend and stretch towards the light, as if eager and determined in their actions; but all these are the effects of foreign agents, not the property of the plants: it is true, that without the possession of life they would not occur, but we have no proof that life is the cause of such actions, because the seed, although possessed of latent life, or the qualifications for vitality, nevertheless exhibits no actions, until acted upon by foreign agents. The mental phenomena are additional to life, and although the organ which is their seat is equally dependent with any other part of the body upon life and organism, yet the higher mental phenomena, which we call intellectual, are, properly speaking, carried on without the action of external stimuli and impressions as their cause. So much in proof of the existence of a mental principle distinct from the vital force.

In the consideration of the phenomena of instinct, it must be allowed we find great difficulty, if not

impossibility, in drawing the line between those actions which are the result of the mental force, and those which are simply the result of the vital or organic force. The bird sings the regular and allotted song of its species; the painted butterfly, released from its chrysalis prison, pursues its sunny way from flower to flower, sporting in luxury; and the old hunter starts at the cry of the hounds, listening with delight to the music which reminds him of the wild and roving chase. Corresponding acts in man could only be ascribed to the action of mind, and that of a superior order; shall mind in a proper share be denied to these creatures? What, then, can we say of the nature of such phenomena, and how far are they different from mental acts? An eminent German physiologist considers that the acts of instinct are performed by the mental force, prompted by the vital principle, and thus admits that "the vital force exerts a direct influence on the formation of internal mental perceptions," and "that it is capable neither of proof nor refutation, that the primary cause of organization and that of the mental phenomena are the same."

"It must consequently remain a matter of doubt whether the presence of the organizing action alone in plants is owing merely to the want in them of the structure necessary for the manifestation of the mind, or whether it is the result of an original difference in the innate 'ideas' implanted in them as organic beings."—*Müller.*

Kirby remarks concerning the nature of instinct, "the proximate cause of instinct must be either metaphysical or physical, or a compound of both characters.

" 1. If *metaphysical*, it must either be the *immediate* action of the Deity, or the action of some *intermediate* intelligence employed by him, or the *intellect* of the animal exhibiting it.

" 2. If *physical*, it must be the action or stimulus of some physical power or agent employed by the Deity, and under his guidance, so as to work his will upon the organization of the animal, which must be so constructed as to respond to that action in a certain way; or by the exhibition of certain phenomena peculiar to the individual genus or species.

" 3. If *compound* or *mixed*, it will be subject occasionally to variations from the general law, when the intelligent agent sees fit."

He proceeds to correct Addison's notion, that " God is the soul of brutes," on the ground of the mistake of the flesh-fly, in laying its eggs in the blossom of the carrion plant, and of the hen in sitting on a piece of chalk formed like an egg, showing that if God directed these creatures immediately, they could not err: some writers think that animals are impelled by what they call an intermediate intelligence, a demon or an angel; we need not stop to point out the absurdity of this doctrine, but follow the treatise. " With regard to truly instinctive actions, they invariably follow the development of the organization; are neither the result of instruction, nor of observation and experience, but the action of some external agency upon the organization, which is fitted by the Omniscient Creator to respond to its action.

" Indeed, if intellect was the sole fountain of those operations usually denominated instinctive,

animals, though they sought the same end, would vary more or less in the path they severally took to arrive at it; they would require some instruction and practice before they could be perfect in their operations; the new born bee would not immediately be able to rear a cell, nor know where to go for the materials, till some one of riper experience had directed her. More reasons might be adduced to prove that intellect is not the great principle of instinct, but enough seems to have been said to establish that point. It should be borne in mind, however, that though intellect is not the great principle, yet it must be admitted that all animals gifted with the ordinary organs of sensation, more or less employ their intellect in the whole routine of their instinctive operations." Mr. K. then gives his own theory of instinct; he thinks that the phenomena of instinct are the result of some physical agent; he suggests the force of gravitation, and after comparing some of the phenomena observable in plants with the analogies in animals, says, "All these circumstances indicate an analogy between certain phenomena observable in the history of *plants*, and some of the instincts of *animals*; and tend to prove that the proximate cause of both may be very nearly related; and that as the immediate cause of the vegetable instinct is clearly *physical*, so may be that of the animal:" and further, "does it seem incongruous that light, heat, and air, or any modification of them, upon which every animal depends for life and breath, and nutrition and growth, and all things, should be employed by the Deity to excite and direct them, where their intellect cannot, in their in-

stinctive operations? Can we not, therefore, conceive that the organization of the brain and nervous system may be so varied and formed by the Creator, as to respond, in the way that he wills, to pulses upon them from the physical powers of nature; so as to excite animals to certain operations for which they were evidently constructed, in a way analogous to the excitement of appetite?"

For our own part, although not pretending to give an opinion as to the precise nature of these phenomena, we cannot help leaning towards a metaphysical theory different from any suggested in the treatise, which would attribute them to the action of the mind, not the intellectual but the brute mind, the distinctions between which we shall have occasion to speak of hereafter; at any rate, so far as those creatures are concerned in which a nervous system has been discovered, we can see no reason why this system should not possess the faculty of mind, although in a very simple degree, and with regard to those below them in the scale, some structure equivalent to the nervous system may exist, though we are unable to find it: the Bee and the Ant, both such remarkable examples, are born, it may be said, in a perfect condition; is it going too far to say that they are, in virtue of that perfected state, and in obedience to Divine design, endowed with perfect knowledge, such as their life requires, just as in man the ideas of death and "right and wrong" are inseparable from his mind and implanted in his nature.

Aristotle says, the *soul* of the Lion is proper to the *body* Leonine, the *soul* of Man to the *body*

human, and every soul its proper body. Harris, in his Philosophical Arrangements, eloquently says, "that strong and nervous leg, so well armed with tearing fangs, how perfectly is it correspondent with the fierce instincts of the lion; had it been adorned, like the human arm, with fingers instead of fangs, the natural energies of a lion had been all of them defeated. That more delicate structure of an arm, terminating in fingers, so nicely diversified, how perfectly does it correspond to the pregnant invention of the human soul." And again, "we can discern that this principle (mind) has many different qualities, and that animals from these *qualities* derive their distinctive and specific characters."

We have seen that all the young of the lower animals exhibiting instinctive acts are born in a more or less perfect condition, *i. e.* comparative with man, who is then the most helpless of all: this is also compatible with our suggestion, that the structure is capable of manifesting mental actions. All these creatures feel, exhibit voluntary movements, and are susceptible of alarm, all which must be classed as mental actions of a certain degree, which one would think sufficient, without the aid and controul of some external, imponderable agency.

> "Dente lupus, cornu taurus petit; unde nisi intus
> Monstratum?"—HORACE.

We shall have more to say upon the distinction between mind and life: for the present we must remain content to say only so much about their differences as to convey a clear idea of mental phenomena in general.

It must be understood that we have been treating of mind in the general, the phenomena of the mental force as exhibited in all animals; reminding the reader that the great superiority of this force in man has been admitted. By comparing those mental phenomena to be studied in the highest brutes with those of man, we shall make a just comparison between the human and brute mind, and this will enable us somewhat to classify psychological phenomena.

The differences to be observed between mental phenomena in brutes, considered apart from their instinctive acts, are insignificant, and not so great by any means as between those of one human mind and another.

The brute mind seems to be formed on a very simple model, and may be reduced to two or three modes, but these we cannot now discuss beyond what is necessary to aid us in exhibiting the manifestations of an analogous although superior force in man.

In the economy of both brutes and man we can perceive that similar or parallel mental phenomena occur. "Ideas" or mental perceptions arise in the mind from impressions on the senses; these ideas will be produced again by the presence of the same impression on the senses, and may be associated or connected with others that have occurred simultaneously or in immediate succession; *e. g. a dog* that has been beaten runs away at the sight of the whip, or the sporting dog exhibits signs of delight and understanding when he sees his master with a gun; now a *boy* is frightened at the sight of the whip

with which he has been beaten, but in addition to the idea of bodily suffering, thinks of a punishment and offence; in the dog a simple idea of the whip is associated with that of bodily pain; but the sight of a gun may give rise in the mind of the boy to the idea of "killing" and "death." The impressions made by these objects on the senses, and the ideas set up in the sensorium, are probably equally lucid and correct in both cases, and the association of the one idea with the other may be equally well performed; but in the brute mind the process is always simple, unaccompanied by an abstract and general idea as to the occurrence of the same effect from different causes: the dog would run away frightened at the sight of a whip, but would look at a knife or gun without any feelings of alarm; it may be remarked also, that as a child grows older, the senses of shame, of punishment, and of offence become more acute and are esteemed of greater importance than the bodily suffering which accompanies them; but whilst an infant all its notions are centred in impressions on the senses; hence the plan pursued in infant schools of impressing all knowledge in this way, either by sight in pictures or diagrams, or by the musical ear in rhymes and songs.

Thus man is the only animal that forms general ideas; this is a highly important distinction, and characteristic of the human mind.

It has been said, that in the lower animals something like abstraction may be observed; that a dog recognizes his master, however he may be dressed, or knows that a hat or a cap is to be used in the same manner, but these instances do not appear to

be satisfactory; in the first case, the animal may recognize its master, as we know often occurs, purely by its senses of smell or sight, and a horse may know that every kind of bridle is a bridle, from the mere recognition of its form; there does not seem to be any thing like abstraction in such acts. Instances of old dogs, horses, and foxes becoming sly, and learning many tricks, as well as finding their way for long distances, can all be reduced to the kind of knowledge required by repetition of the same ideas, which affords them a sort of experience and rude memory.

Again, in man we may have combination or connection of simple ideas, arising from an impression on the senses, either with a simple one of similar kind, or associated with an abstract idea, or two abstract ideas may be associated; *e.g.* I take a piece of iron into my hand; the ideas of its weight and temperature arise in my mind, which are simple ideas, the result of sensation; but I look upon a bar of iron, and the idea of its properties and utility arises, which is the abstract idea without any sense of impression. So again two abstract ideas are associated when we think of the art of "painting" and "beauty." We submit that the former process, viz. the association of one simple idea with another, does occur in brutes, but the two latter never occur but in man, seeing that they involve abstract thought.

The desires and passions are equally active in men and brutes, but we find that these cannot be excited in brutes by abstract ideas as they are in man; the dog and other domestic animals exhibit fidelity and attachment, merely as the result of asso-

ciating power of mind: the sight of the master is associated with the pleasing ideas of food, a natural vital impulse; but the idea of "a master," or of "death" from being deprived of food, never arises; it cannot be sustained by the brute mind.

Many very interesting and remarkable stories are told with regard to these feelings in animals, but however our sympathetic feelings might induce us to attribute their performance to the promptings of sentiments similar to our own, we must be careful how we thus characterise them; many anecdotes are told of the reasoning powers of animals, which are certainly difficult to account for, amongst monkeys, elephants, dogs, horses, &c.; every one has witnessed instances of the kind.

The grand feature which elevates the standard of the human mind is in the forming of general ideas, laws, and language: these require superior mental action, in connection of course with a perfect state of bodily or vital organization; in confirmation of this it is very interesting to observe, that in sleep, and feverish delirium, these superior mental operations cannot take place, and often language is then totally prevented, inarticulate sounds only being uttered; yet the formation of simple ideas parallel with those of the brute mind does occur; the delirious patient, impelled by parching thirst, swallows his dose of medicine as he would any liquid offered to quench his thirst, and forms no idea of its being the means of his recovery, in fact, the idea of his illness does not exist. So in drunkenness, the man is reduced to the level of the beast, in every sense of the word, for he is susceptible only of simple ideas from impressions.

B. Special mental phenomena, or those of the human "mind."—In treating of this branch of the subject it will be our aim to give a general view of the faculties of the human mind, in as short and concise a manner as possible, without entering into the speculations as to their mode of operation or mental relation, which points indeed we shall consider in another place.

We have hitherto spoken of mental phenomena, both in man and lower animals, referring to certain distinctive characters of the human mind, to which we must now direct our attention more particularly, in order that a clear idea of the various kinds of human mental action may be formed.

This subject will require the reader's utmost attention, but we shall endeavour to divest it as much as possible of the usual metaphysical difficulties; we will abstain from entering upon the discussion of the various classifications of mental phenomena and the theories of their action, until we enter upon the subject of the combined operations of life and mind.

The various divisions of the powers of the mind that have been proposed are all liable to objections; it is said, and with perfect truth, that there never has been any one that is not objectionable; some are too complex, and consist of numerous subdivisions, as the phrenological; others too simple, as in that which divides into the "will" and the "understanding;" we find another, which arranges into "simple apprehension," "judgment," and "reasoning;" this is founded on the successive steps by which the mind is said to arrive at any knowledge, 1°, by the senses; 2°, by comparing ideas or judg-

ment; and, 3°, deducing conclusions from judgments: but the powers of the human mind are so connected one with another, that all seem to be concerned in every action of the mind, and we find the greatest difficulty in attributing it to any one faculty which we are in the habit of speaking of. Reid is opposed to any divisions in a subject so imperfectly known, and prefers merely to treat of certain faculties, as the senses, memory, conception, power of analysing and resolving, judging, reasoning, taste, moral perception, and consciousness. Our aim will be to analyse these still further, and endeavour to reduce them to a general system of action, with what success the reader shall judge for himself.

We have seen that "*abstract*" thought is the grand characteristic of the human mental phenomena; now there is a state of the mind, of which every one is aware, which may be considered as a form or mode of abstract thought; this is "consciousness," or "self-consciousness," as it is also called; to define this condition is much more difficult than to understand what is meant by the terms in common use for expressing this state: we say a man is "quite himself," or "quite sensible," or "understands" what is said or done, or is "come to himself," all which signify that the mind is active, through the proper condition of the brain. Again, every man, when he speaks and thinks of "himself," forms naturally, by virtue, however, of his mental powers, an abstract idea of something which he connects always with his body and all his actions and thoughts; he knows that this is always the same, however his body may be changed, he feels that it

is different from any thing else of which he is cognisant—he calls it "self," and it is wholly expressed by the personal pronoun; this notion of self, or egoism, is completely common to all races of men, for it is expressed in all languages.

But although we connect this "self" with our body, because it commands and controuls the body; yet we are all aware that in thinking, our body may remain passive, however actively our thoughts are engaged; thus we form a very distinct idea of our individuality and egoism, and of the action of a part of our nature very different from the body; the subject of this idea we call "self," and the action we call "self-consciousness."

This mental condition is highly important, for we find it to be quite the basis of all thought, and when it does not exist, either no mental phenomena at all are ascertainable, or they become materially altered in character, becoming more like those discovered in brutes, as we mentioned when speaking of abnormal conditions of the brain in delirium, madness, drunkenness, idiotcy, &c.

Upon the existence and operation of this phenomenon of consciousness is founded the whole doctrine of man's responsibility to the laws both of God and man. A man in a state of somnambulism or intoxication loses this consciousness, and may commit acts for which he is not reasonably held responsible.

No process of thought can occur without this state of consciousness; it is the very test of the proper action of the mind and the condition of its organ, the brain; a man receives a blow on the head, the conditions of the brain are disturbed, and

all "consciousness" ceases; he can no longer perform the part of an individual, his egoism is destroyed for the time, and no mental phenomena are manifested; he becomes subject to all the laws which regulate vegetative and instinctive life, as in some experiments we shall have occasion to mention, where a state is produced by stunning or otherwise injuring the brain, in which an animal remains torpid, except when scratched or pinched, when it is roused, as it were, for a time; it is doubted whether any sensation accompanies such movements, it has been suggested however, that even in this state the phenomena of dreaming may occur, but these, when occurring in the natural way during sleep, are to be essentially distinguished from the higher modes of thought which are connected only with consciousness.

It is scarcely necessary to say that the brutes conceive no idea of "self" in the manner we have spoken of; their instinctive acts have certainly a reference to self, but they have no dependence upon an action such as we have been considering, no abstract idea of self, no egoism.

During the condition of consciousness, our "self" takes notice of certain ideas that occur to it, by virtue of this state of consciousness; as when I hear the sound of a trumpet, I see, as it were, a trumpet with my mind's eye, and the idea of the sound produced occurs at the same time; this action is called "the conception of ideas," another very important mental phenomenon, so constant and untiring in its operation, and so necessary and important in connection with all thought, that an eminent phy-

siologist has said that all mental action consists in "the conception of ideas and emotions."

We have admitted the existence of ideal phenomena in the lower animals, but we saw that they do not possess some important properties in connection with the ideal faculty.

In man the ideal action may be simple or complex, or the one mode may combine with the other; these processes have been called "conception" and "association" of ideas; from the combining and comparing of ideas we infer the existence of a faculty which is named the "understanding."

As to ideal action.—*Ideas* are excited either by (*a*) *impressions upon our senses*, as when we look upon a coloured object, and possess the idea of blue, green, red, yellow, &c.; these may be called *simple ideas;* or (*b*) *by the connection of one idea with another*, as when we conceive the idea of "colour," in connection with the perception of "blue," or of "sound," or "smell," or "taste," from their respective senses. These may be called compound ideas or "general ideas," because they refer to the general properties possessed by a number of objects which have been the subject of simple perception; another class of ideas (*c*) may be stated as formed of *those which arise from the combined operation* or occurrence *of the two above mentioned*, as when we conceive a colour, *e. g.* "blue," of a relative intensity or shade; or a musical sound of a certain definite pitch and intensity, and thus it may be shown that all thought is reducible to the connection of one idea with another.

There appear to be two grand modes of the

mind, viz. "consciousness," and "the conception of ideas," which we have seen are dependent the one on the other. It may be asked by some, is not this simplifying the philosophy of mind too much? and carrying the principle of analysis too far? but if we reflect it will become evident, that from these two sources arise all the phenomena of the mental force; it deals with ideas by its consciousness, conceives them, combines them, compares them, reasons upon them, and judges accordingly, and upon the power and capability of dealing with abstract notions and general ideas, which is only another expression for the lucidity and completeness of the abstract ideal action, depend the characteristics of the human mind and intellect, embracing the formation and use of language.

But we proceed to speak briefly of some secondary processes in connection with ideas; and, first,

Of the imaginative mode.—A vast proportion of our ideas have reference to material objects, being the result of impressions on the senses, or caused by the association of one idea with another, but all in a chain, from the object in which it is or has been presented to the senses.

But the mind, differing as it does so essentially from matter, is ever active, even in connexion with organism, hence we find that it can form ideas without the aid of any impression upon the senses, or any evidence of such an action, but by consciousness alone. The most intense reflective thought, and the "fancy" or imagination, are examples of this condition; there is no need of the presence of any object in such actions; however it must still be allowed,

that with the exception of those ideas which may be considered as the properties of the "soul," such as the idea of a God, of right and wrong, moral responsibility, sense of immortality, and knowledge of death, all ideas have reference to objects that have at some time or other made an impression on the sensorium.

But we may conceive of things that never existed, and that never could exist, *e. g.* a planetary system without the force of gravitation, yet it will not be denied that our idea of the sun, moon, and earth would then be derived, indirectly, from impressions received from the real object, while the presence or absence of the gravitating force is equally well conceived in the same manner: so we may imagine a horse with wings, or the body of a man with the hind and fore quarters of a horse, or the head and body of a woman with the tail of a fish: by these examples it will be understood, that in the imaginative mode various images are readily combined, and even impossible images conceived; that is to say, certain simple or general ideas, or both combined, which have once occurred to the thoughts as the result of impressions from objects, may be recalled, and again set up in the thoughts with more or less precision, as it were by the spontaneous action of the mind; and in proportion as they are simple or complex in relation to real objects, so are they more or less the effect of the imaginative mode.

In this phenomenon of spontaneous action, if we may so say, of the mind, something more is to be noticed; we have allowed that ideas always have reference to an impression, but yet it is not necessary

that the object which caused that impression should be present—this looks like a paradox; the truth is, we find that an idea remains dominant in the mind for a time after the impression causing it has been removed, in a manner analogous to the duration of the image of an object of sight, which remains for a few seconds after the object is removed from vision. The lucidity and preciseness of the idea are generally dependent upon the length of time elapsing since the occurrence of the impression. Upon this faculty or property depends what we call memory, which consists in the reproduction of any idea that had faded or become dormant, and the setting up of that idea in a manner as if the original impression was present and causing its action.

Memory may be reduced entirely to the process of association; one idea acts upon the sensorium of the mind in the way to produce another connected with it in some manner, either by time, locality, or properties, until a complete chain is produced by which we arrive at the idea we remember. In proof of this, let us attend for a moment to the process. I have travelled a journey; after a lapse of time I wish to relate to my friends all the events that happened during that journey. I commence from the first or last event in connexion with it, and by dwelling upon each event as I relate it, another arises in association. But it will be asked, do ideas never disappear entirely, do they never cease to exist? It is highly probable that no idea is ever lost, that is, that any idea having once existed may be called into action again, without the aid of the impression that originally caused it, but by the ope-

ration or association of another idea, or the material conditions which accompany it; ideas are said to be latent or reduced to the general equilibrium of the mind when forgotten; the state of disturbance of this equilibrium by the action of any idea previously latent is "recollection."

Somewhat analogous to the conception of ideas and the recollective faculty is what we call *reflection* in contemplation. Reid speaks of "a train of thought in the mind;" he compares it to a fermentation or intestine movement, and an ebullition; he says "every operation of the mind, excepting those of sense, is exerted occasionally in this train of thought, memory, judgment, reasoning, passions, affections, and purposes," and that they either "flow spontaneously, or are regulated and directed by an active effort of the mind with some view and intention."

"We seem to treat the thoughts that present themselves to the fancy in crowds, as a great man treats those that attend his levee. They are all ambitious of his attention: he goes round the circle, bestowing a bow upon one, a smile upon another; asks a short question of a third; while a fourth is honoured with a particular conference: and the greater part have no particular mark of attention, but go as they came. It is true, he can give no mark of his attention to those who were not there, but he has a sufficient number for making a choice and distinction."

He considers memory to play a principal part in this kind of action, and that in such reveries we judge and reason about things as well as persons.

Harris in his "Arrangements" says, "the last and most excellent sort of action is seen in contemplation; in the pure energy of simple intellect, keeping within itself, and making itself its own object. This is the highest action of which we are susceptible, and by it we imitate the Supreme Being, as far as is consistent with our subordinate nature. 'Tis to this that our great poet alludes, when speaking of his employment, during a state of blindness, he says,

> 'Then feed on thoughts which voluntary move
> Harmonious numbers.'"

We have next to consider an interesting and important mode of the mind which is particularly human in its character, called

"*Reasoning.*" This process has been much studied amongst the ancient philosophers; it retains the same name and character as it did in their day. Perhaps it may with truth be said, that the phenomena of reasoning are not seen at all in the lower animals; certainly, as far as regards most processes of reasoning, this would be true, but it is difficult to pronounce as to some cases related of brutes, *e.g.* dogs have been exhibited who can play at dominoes; it would appear to us that the conception of number is an act of reasoning; at any rate it requires superior mental power; we know that idiots and insane people are frequently tested by questions having reference to the value of figures, yet here are two brutes which appear to act by these faculties, but whether they know the pieces by their relative numbers or their mere appearance, must be very questionable.

In accordance with what we have said concerning

abstract thought and general ideas, as characterising the higher mental manifestations, and as reasoning, we all know is equally dependent upon high mental exercise, we may expect to find these processes analogous, and we shall endeavour to show this.

In speaking of abstract thought or the formation of general ideas, we saw that it was necessary to see a difference between a number of objects and a general resemblance; now the idea of a difference between objects is in fact the simplest form of reasoning; by this we arrive at the conception or idea of two objects. Unless we form the idea of this difference, more than one idea could not exist, *e. g.* *a* is *a*, 1 is 1, and 2 is 2, because there is but one idea can be formed from either of those expressions, for we cannot conceive of "*a*" being different from "*a*," or 1 from 1, &c., the thought is impossible; so the "conclusion" is at once formed, that $a=a$, $1=1$, $2=2$, therefore they are the same, and two abstract ideas cannot be formed from any one of them.

The idea or conception of what a thing "is," is dependent upon the formation of simple ideas and abstract ideas, and at the same time a process of reasoning, therefore the studying of the properties and qualities of bodies, and the consequent generalizing of these in the classification of such bodies, is essentially a ratiocinative process, and one that requires superior mental powers.

In the process just referred to we have to deal with objects possessing sensible properties, and therefore exciting simple ideas as well as abstract notions, but in higher kind of "reasoning," in which the operation is entirely of an abstract nature, the ideas

are wholly general or abstract; *e. g.* we allow our mind to entertain the "proposition," that "the whole is greater than its part," or "if equals be added to equals, the products are equal," the process is wholly of the abstract kind, and the truth arrived at is of general application. This is a process of a superior nature to association, although it must be admitted that it is difficult to distinguish it completely from association, for abstract ideas may be associated as readily as simple ideas, *e. g.* "God" and "worship," "happiness" and "mirth." So it has been asserted that "reasoning" is only a higher grade of "intellectual association."

Now we could desire to describe the actual process of reasoning in the same way as we can that of "sight" or "sensation," but the attempt seems like absurdity. However, the object we have in view is to reduce the number of mental faculties, as they are called, and to show how far they may be assimilated, in the hope of being able to classify mental phenomena more than has yet been done; so perhaps with regard to the phenomena of reasoning: this much may be said, that whatever be the process of forming abstract ideas, or however they arise in the thoughts, that of "reasoning" is highly analogous, if not a form of the same mode of mind; such a doctrine simplifies the subject, and does away with the necessity of finding organs in the brain for every action of the mind we may choose to call distinct and separate, and which the phrenologists designate as faculties.

Emotions.—We have as yet spoken only of mental phenomena, the operation and occurrence of

which are not particularly indicated by effects upon any other part of the body besides the brain; now there are certain states of the mind which are intimately connected with certain actions of the body; these are called "the emotions" and "passions," such as "anger," "love," "veneration," "joy," "grief," "fear," "hope," "revenge," vanity," &c.

Whole volumes have been written upon the statics of the emotions, and upon the different conditions of the body which exhibit them; the great art of the historical painter consists in pourtraying these; the poet does not forget to describe the feelings by the attitude and countenance of his hero: the tragedian studies minutely every attitude and semblance of passion which can be seen in the body that yields to the spirit within, and marks each shade on the features, that tell of "the mind diseased," while the voice of the singer tells the tale of love, of joy, and sorrow: all nations, whether rude or cultivated, have their wars, their music, and their dances, which it need scarcely be said are emotional signs.

The emotions differ very much from other mental conditions in their being more or less connected with effects upon the bodily system, which are for the most part not controllable by the will: our feelings may be so aroused by the relation of some tale of woe, that even the tears flow; or in paroxysms of more real and selfish grief tears are accompanied with convulsive sobs and cries of distress; in some instances, the bodily effects of joy, fear, or grief have been attended with more severe results, such as madness, idiotcy, and death. The first efforts we make to avoid personal danger when suddenly oc-

curring, appear to be of a different nature from cooler acts of reason; they partake of a convulsive character: the start and exclamation of sudden alarm are beyond the controul of the will—the rapid withdrawal of any part of the body upon which some pain has been suddenly inflicted is of the same kind. All these acts are accompanied too with very rapid beating of the heart and quickened breathing; hence the vulgar and old notion that the heart is the seat of the passions, so that the name even of the organ is synonymous with feeling or sentiment.

The descriptions of the emotions found in works upon the human mind, although very eloquent and interesting, and exhibiting so much metaphysical research, are unsatisfactory, inasmuch as since they were written, discoveries have been made in the physiology of the nerves, which enable us in a great measure to explain such phenomena: to these we shall refer more particularly in the next division of the work.

The psychology of emotional phenomena cannot, at least so far as we are able to judge, be made out in a satisfactory manner; the latest physiological opinion to be found upon the subject may be sketched in a few words: it is said that, besides the mode of "conception of ideas," the mind is capable of another, which is caused by an idea, but which is something distinct from the idea, which is called "emotion," as when the idea of the death of a friend, although only imagined, occurs to the mind, the emotion of grief is felt to a certain extent; the lucidity of the idea, or the conviction of its reality,

does not affect the idea itself, but increases "the emotional action."

Emotions are considered also to have an especial reference to individual existence, to "self," and to resisting any diminution of that self; this is called "a striving of the mind:" the "meum and tuum" are especially concerned in all emotions. It is said, according to this view, that the interest we feel in the fate of others variously related to us may be explained, and that the various violent opinions which men hold by the prejudice of habit and education, &c., can be explained, because they have in a measure become identified with themselves. It is said that every thing tending to oppose this striving for integrity produces a depressing effect upon the mental power and the corporeal actions, while on the contrary, every thing that favours it exerts an exciting influence upon sensation and motion.

We have only alluded to the *properties of the soul*, which are the most important and wonderful of all; and it is remarkable that their existence can only be accounted for on the system of religion taught by the Bible; they may be called the general phenomena of the human mind, in contradistinction to those which are the special result of culture and education, and because they are possessed in equal force by all men. To enter fully into this subject would, however, lead us too far from the main object in view, the action of mind in connection with the body.

The phenomena of the human mind, which we have thus briefly described, are found in greater or less perfection and activity in all human crea-

tures of sound mind, and therefore we say that all human minds are formed on the same model, but admitting of all the varieties, so far as mental properties are concerned, that differences of organization, education, and habitual exercise can produce; modern researches concerning the tripartite, and consequently the Adamic, origin and descent of our race, seem to leave but little room for doubting that the varieties of the race are modifications of one original form, not more easy to be discerned than the differences, accompanied however by general characteristics, in the mental powers.

It is highly desirable that the phenomena of human mental action should be analyzed and decomposed as far as possible, that we may arrive at the elements of their composition; this appears to be a more philosophical and correct plan of study than that of considering every faculty or operation of the mind as one by itself, and of looking constantly for fresh faculties; for by this method, we may be led to give a distinguishing name to an operation which is really only a modification of another faculty, and thus pave the way to endless subdivisions and intricacies.

The study of the anatomy of the brain, both superficially and intimately, does not warrant us in supposing that any arrangement of its structure exists by which one portion may be in any way more active, in a normal state, than another, which would, we conceive, be necessary for the support of a doctrine of many faculties; indeed, so intimately connected is every part of the organ of the mind, and so very little appearance of subdivision

of its structure exists, that the doctrine of its united and general action seems most feasible, and not the less so when it appears that the phenomena of mental action, although said to constitute so many and such varied faculties, may be reduced to a few modes of the mind; but to this subject we shall recur with the intention of fully considering it.

C. *Deductions respecting the mental and instinctive phenomena,*—from what has been stated above, we may venture to arrange these under the following heads:

I. *Mental.*

1. The force of mind is always active, in contradistinction to the "vis inertiæ" of matter.

2. Mind being "essentially" active, can act without any external stimulus, and in connection with this property, possesses self-consciousness, egoism, and power of reflecting upon itself and its actions.

3. The action of the mental force, although "essential," is dependent upon organization, so far as we are able to observe.

4. The mental force is not manifested, unless certain vital conditions are fulfilled.

5. The mental action has duration.

6. It has reference to objects and impressions, directly or indirectly, either by direct impression or by association.

7. The effects of an impression, whether "ideal" or "objective" may be produced again in a more or less perfect manner, as in "memory."

8. The action of the mind being to a great extent independent of the body, it controuls its own actions

and those of the body, in the condition called the exercise of the "will."

These may be said to have reference to mental phenomena in general, though that at 2 refers more especially to those of the human mind, or what we call intellect.

II. *Instinctive phenomena.*

1. Cannot occur without life and organization.
2. Are performed perfectly and with certainty.
3. Are not improved by education.
4. Are not guided by the will or reason.
5. Doubtful whether the result of any ideal action.
6. Have particular reference to the preservation of the species, in both young and old.
7. Are uniform in their action in all animals of the same species.

The following arrangements exhibit an attempt to classify psychical phenomena, and it is hoped will be looked upon only as such, and not as making any pretensions to completeness; it has been done with a hope to render more clear the writer's views with regard to distinguishing the possession of mind by animals in general, from the gift of superior mental power, called intellect, held by man alone, so that there may be no confusion as to the meaning applied to the words "mind" and "intellect."

With regard to the moral sentiments, it was thought desirable that they should be classified separately, as being possessed, irrespective of education or culture, so far as their fundamental principles are concerned, by all races of men in all ages, while intellectual powers and acquirements vary in every individual of every race in every age.

Classification of Psychical Phenomena.

- I. Intellect
  - (A.) *Intellect* not dependent upon organization or *Soul*.
    - Operations of the Divine mind.
    - Consciousness and "*conscience*"
    - idea of immortality—of the "*self*"
    - belief in the existence of a Deity
    - "social faculty"—idea of death.
    - Intellectual powers of mind.
  - (B.) *Intellect* dependent upon organization, or, Intellect proper.
    - The psychical manifestations of refined character, the result of education and culture in the highest degree—the peculiarities of the human mind, and the distinctive marks between man and man;—power of forming abstract or general ideas, as in the comprehension of "cause" and "effect," of "genera" and "species," of a "law," and reflection.
    - * Questionable whether some psychical phenomena, seen in very inferior men and in the highest of the lower animals, may not be said to partake in some measure of intellectuality.
- II. Mind
  - Psychical manifestations in all animals possessing a cerebral collection, such as perception, conception of ideas, associating power, the action of the will, the emotions.
  - * Questionable whether some instinctive phenomena may not be the effect of the mental force.
- III. Instinct
  - Pneumatological actions, having reference to the body, of most importance and most evident in the infant, in human monsters, in lowest animals, and those in which no cerebral collection exists; when occurring in higher animals and man particularly, unconnected with the will.

TOPOGRAPHICAL ARRANGEMENT

OF

PSYCHICAL PHENOMENA.

I. Soul.....	Deity. Man alone.
II. Intellect	Mankind in the highest state of intellectual cultivation. Men surrounded by sources of knowledge, but ignorant, though influenced by such circumstances to a certain extent. Men lowest in the race, as Bushmen and Hottentots. * Questionable how far brutes may not be admitted to possess intellectual properties, as the Chimpanzée, apes in general, dog, elephant, horse, &c.
III. Mind ..	Mankind generally. Higher animals;—Animals lower in the scale, but possessing distinct cerebral collection. * Questionable as to animals below the crustaceæ, and insects.
IV. Instinct	Man, more especially in the early stages of life. Higher animals, in conjunction with mind. Lower classes of animals universally.

D. *Speculations concerning the cause of mental phenomena and its nature.*

In describing the mental phenomena we may be said to have considered their proximate causes: we have spoken of the power of forming simple ideas and general ideas, of an imaginative action, an associating power, memory, consciousness, reasoning, moral feelings, and emotions; all these modes or faculties of mind seem to constitute, either singly or combined, the various mental phenomena of which we are conscious: but when we endeavour to describe the ultimate cause, we find ourselves at a loss;

not only the subject cannot be perfectly studied, but the cause itself eludes our senses and remains involved in the greatest mystery; were we to pretend to point it out, and to explain its precise nature with any degree of confidence, we should be doing harm to the cause of science, for it is much better to point out what we do not understand, than to frame hypotheses which give confidence in a false knowledge, and serve only to explain without affording the satisfaction and conviction of having arrived at "the truth," which is the aim of all philosophy.

But let us refer to some of the theories upon this subject. In the cosmological systems, as they are called, referred to in a former part of our work, we find the subject of mind treated precisely in a manner parallel to that of life: it will be remembered that two grand systems were described, the one that of the Pythagoreans, Plato, and many in the present day, which considers all the phenomena of "mind" and "life" to be the result of an immaterial agency, connected with the body in a highly mysterious manner, but deriving its force and operation as an emanation from the Deity, capable of existing apart from matter, and returning, when separated from it, to the Deity; such is one view as to the nature of the cause of mental phenomena: the other, very much the reverse, at least so far as its relations are concerned, is ably supported by the works of Lucretius, Stahl, Spinosa, Giordano Bruno, and latterly by the Pantheists, &c. It teaches that "life" and "mind" are the properties of all matter; it admits the existence of such inappreciable forces, and ascribes their operation and power to the Deity,

but contends that all matter is equally endowed with "life" and "mind:" according to this theory it will be seen that the nature of the cause, so far as its immateriality is abstractedly considered, is admitted; but it is as if it were disputed, because if "mind" and "life" are essential properties of matter, then so long as matter exists, "mind" and "life" exist with it, and if "matter" could be annihilated, it follows that "mind" and "life" would be also.

Perhaps enough has been stated, in what we have said of vital and mental phenomena, to prove that this doctrine of Pantheism cannot be upheld by our observations and reasonings; if "life" and "mind" were the properties of matter, it could not be deprived of those properties without destruction to itself, but this does not occur, for we have seen that at death, when mind and life are no longer manifest in connection with the body, the matter of the body remains the same, so far as all the characters and properties of matter are concerned, the same in weight and appearance, yet so great a change has occurred.

The doctrine of materialism is in effect very similar to that just given; it considers the mental phenomena to be the result of material actions, and consequently to cease with them entirely; it differs, however, on the question of the connection with the Deity, for though with such views, the belief in the existence of a God is not incompatible, the immortality of the soul must be so.

Other views with regard to the vital phenomena were mentioned which serve to explain or account for the continuance of life and the manifestation of

vital phenomena, by considering organic matter, structure, chemical composition, and concurrence of vitalized matter, as together constituting a living body, without the addition of any material or immaterial vital principle; such a view being admitted with regard to life and vital phenomena, which we have all along compared with mind and the mental phenomena, and between which we have traced great analogy, it becomes a question whether "mind" may not be considered also as a nonentity or a thing inseparable from the necessary and proper organism by which it is made manifest, and consisting in the sum of the actions of the organism of the brain.

If we take "mind" to mean the force which enables many of the lower animals to perceive certain simple impressions, and to possess certain concurrent simple ideas only, without any abstracting mental power, then there would not be much hesitation in adopting the view just mentioned, because we can easily perceive that the very simple psychical power of brutes is scarcely more refined than their vitality, and much more closely connected with the body and mere organism than in man, the great difference between the two being in the power of forming abstract ideas, or those remote from material objects and impressions.

The nonentity view then may be applied to explain the mental phenomena and the nature of their cause in brutes, for with their life mind also vanishes, and we can conceive no reason why it should be otherwise; possessed of high vitality, they have but a simple mode of mind; deprived of abstraction,

and consequently of reason and language, they lack all notion of egoism, and have no ideas of death, of immortality, and of a Deity: thus they are but fit for man's use, and their end is but to perish.

Let us see how far the same doctrine would apply to the human mental phenomena. We have already observed that analogous mental phenomena may be seen in man and brutes to a certain extent; it was remarked that man, when reduced to the grade of brutes, either by the effect of delirium, intoxication, or mania, would exhibit brutish actions, referable to the most simple mental action, which we called the simple ideal mode; during such a state the human mind is made parallel with the brute mind, the human creature has then no power of abstraction or reasoning, no egoism, no consciousness, no idea of death, no moral responsibilities: if we consider the case of an idiot from birth, in whom none but the mere brute qualities are manifest, we cannot allow ourselves to believe that such a creature possesses any of the high intellectual and moral powers of a proper man, and grievous as the thought may be, we cannot believe that such a creature, devoid of every faculty that makes a man divine, could after death become immortal; but when we attempt to conceive the human mind in a complete sense, with all its powers of abstraction, intellect, and soul, to be the result of organization and a nonentity, how does our spirit recoil from the thought, as if offended at the bare idea: had we not been able to point out the immense differences, intellectual as well as moral, between the human and brute mind, and the peculiar possession by man of properties of the soul

involving the longing for immortality, and desire for happiness manifested by men of all nations in all ages, there might be some reason for denying the essence of his being; the promptings of the spirit within us compel us to believe that the mind of man is of too noble a stamp, of too celestial a quality, and an essence too deified to be levelled with the dust of brutes; such a sentiment does not commend itself to our common sense, much less to our consciences and our inbred feelings as men so full of hope, so longing to live.

Were it not for the indisputable evidence derived from the properties of the soul and the abstractive powers of the human mind with which they are connected, we might be permitted to apply the nonentity view of life to the explanation of the human mental phenomena; but this we have seen cannot in any way be admitted.

The doctrine of the existence of an immortal spirit superadded to the body cannot be accused of irrationality, for it does not require any great stretch of our reason to comprehend the existence and operation of such a force; indeed, philosophers of the physical sciences do not hesitate to explain phenomena of the material world by the existence of various imponderable forces, with all the certainty and confidence that language can convey and mathematics enforce.

It is useless to attach too great importance to any definition of "mind" that could be given, because every one can understand what is meant by his own thoughts and "conscience;" yet in discussing the nature and properties of any object it is highly de-

sirable that as clear and definite an idea of it should be taken as it is possible to express in language. All definitions of such an "idea" as the mind must of necessity be imperfect, because it belongs to that system of "essences" to which the terms of conventional language and logic are in a great measure inapplicable; it is true that operations of the mind have been demonstrated by means of the algebraical signs, as when we express the increase or decrease of an emotion by $a+a$ or $a-a$, yet this is only an abbreviated expression of the dynamics of the operation, and leaves us as far as ever from the value of a.

To hazard a definition in words, it may be said that by the "mind" we mean the thinking part of our nature, the conscious self; the manifestation of an entity or essence not subject to the laws of matter, indivisible, and unity itself, resembling the idea of "a point" with mathematicians; not subject to change, but in virtue of its mysterious connection with "organism" it becomes susceptible of certain modes, which we call powers of "mind," in which consists human knowledge and improveability.

It is common to speak of a mind increasing in power or capabilities, but such an expression is both incorrect and inapplicable to its subject; it is as absurd to speak thus of "mind" as it would be to talk of the expansion of "a point" in geometry. "Mind" is as distinct from "matter" or substance as "quantity," "time," or "number" are from "the Deity;" with "life" it is conferred upon "the body," as a most perfect spirit, such as it may exist in the future and final condition of our race: its manifesta-

tions, while connected with our bodies, are of course modified by the state of the organism it inhabits; as in plants and lower animals various subtile differences in vital properties are manifest from time to time, according to the age and perfected state of their organism, so in man we find that in the infant, the "organism" in general being in a progressive state, and as regards the brain particularly so, is accompanied with psychical manifestations but very little above the instinctive and brutal acts, yet we cannot but think that the mind itself is quite perfect, for we cannot conceive of a mind in any other way; not being made up of parts, no accession to it can occur; but as the organic force proceeds in its operations, and the organization becomes completed, this spirit is enabled to develop its powers, and to shine forth as a reflected radiance from the mind of the Deity, whose power and will called it into existence, and who has decreed its immortality.

E. *The possible existence and operation of "mind," independently of matter.*

In our opening remarks upon the subject of "*mind*" we showed, that because of the mutual arrangement and operation of the system of the universe, as well as in the conception of such a complex idea, another force, of a nature widely different from "life," and the cause of all the harmony of the natural world, must be in existence; we cannot account for all by the operation of "life" alone, for we find that matter deprived of life is acted upon and acts upon matter in a regular, definite, and useful manner, subservient to "a law;" therefore we conclude that a force exists by which "a law"

has been conceived and its operation effected; thus we showed the existence of "mind."

The celebrated Stahl attempted to prove that phenomena of every kind are the result of mental force, that all atoms possess mental force, and that in acting upon each other they obey a mind: certainly the operation of matter upon matter is controlled by a mind, but the residence of that mind in such atoms cannot be admitted; however, it is impossible either to prove or disprove such a doctrine, we leave it for the reader's common sense to deal with.

We have said that "action" is a property of mind, by which it is meant, that the mental force acts as an "essence," that it is not dependent upon the concurrence of any thing else for its action. In thought the mind acts, it wills to think; and though organism may be the vehicle of this action, yet it is not the originator of it; the particular thought is regulated by our "self." Now we know that all matter is so far devoid of this kind of action, that it really possesses a force the very reverse of it, the "*vis inertiæ*;" and even with regard to the imponderables, light, heat, electricity, &c., we have no proof whatever of their action without some other substance, and the latest ideas entertained incline to show the existence of a general ethereal medium, which is the sphere of action of all the imponderables, and probably of the chemical force. It will be said that the same argument applies to the action of the mind, and that its action without organization cannot be proved: we admit the difficulty; we allow that the mystery cannot be unravelled according to our phi-

losophy, so we leave the question to the common sense and conscience of every man, whether, while his mind is occupied with thought, any thing like the action of matter upon matter is proceeding.

The action of the mind is not limited by the laws of matter; when, for instance, in imagination we see with our mind's eye all the romantic and beautiful scenery of the Alps, the act of the mind may be as vivid as if the objects themselves were present to the senses: so in dreaming and phantasms, the mind appears to act, as it were, spontaneously. An old doctrine was upheld, that the mind walked out of the body, and visited any object which it perceived; it would be idle to refute this, but it suffices to show, that the characteristic action of the mind was naturally and properly conceived by such a view.

Lastly come the powerful arguments of conscience; all mankind, it is said, have faith in and long for immortality; it is an innate prompting of our nature, we could not be happy without such an idea; none but the man who has degraded his mind by every vice and crime, would wish to be deprived of this belief; to think that his soul shall be destroyed with his body, may be his aim; he may try to "lay this flattering unction to his soul," but the "immortal spark" cannot be quenched, it cannot even be hidden; he still as firmly believes that his spirit, his individual self, must live for ever.

We have said thus much concerning the separate action of the mind, or its independence of matter, in order that this branch of our subject may be rendered more complete, and that the reader may be prepared to understand more fully the grounds there

are for taking those views in reference to the connection of mind and matter, and the influence of one over the other, which we shall have occasion to bring forward in the third part.

F. *Varieties of mental manifestation.—Powers of mind.* It will be asked by those who uphold the doctrines of Pantheism, Materialism, and many of the phrenologists, how varieties of mind can be accounted for upon any other doctrine than that which teaches the differences between minds to be just the differences between different kinds of matter. For the present we must be content to say, that although the complete independence of mind from the body must, we think, be allowed, yet that so far as this mundane state is concerned, its manifestations are modified by certain conditions of vitality and organization, especially as regards the brain, which is the organ of the mind; but to this interesting and important subject, upon which so much has been written, we shall devote our attention more fully under a distinct head.

PART III.

COMBINED PHENOMENA OF "LIFE" AND "MIND."

INTRODUCTION.

THE contents of the present section may be said to have a more practical bearing, because, apart from the somewhat abstruse subjects referred to in the preceding parts, we shall now be in a condition to enter upon the consideration of the physiology of the brain, the organ or seat of the mind, and of the nerves connected with it, and acting so important a part in sensation and voluntary controul; we shall also be able to support and aid our observations by facts met with in medical and surgical practice, having reference to various conditions of the bodily structure.

The numerous theories which have been advanced respecting mental action, the seat of the soul, the residence of particular faculties, the emotions, &c., had they been founded more upon facts of physiology, anatomy, and pathology, and less upon the conjectures of their authors, would have been less erroneous: we shall enter rather fully into the subject of phrenology, or, as it should be called, craniology, as referring rather to heads than minds; this will lead us to describe the minute structure of the brain and nerves, as well as their external form, though in a manner as brief and as much devoid of technicalities as possible. The different degrees of

mental power which form the grand characteristics between man and man will afford a subject of much interest; we shall offer some views respecting these, and the theory of mental action in general, founded upon physiological notions, but calling perhaps for the indulgence of the reader for their crudity.

Having experienced the difficulty of entertaining fully the subject of the physiology of the mind, without having previously attended to that of "life," and the mental philosophy of the schools, it seemed best and almost necessary to treat, first, in a somewhat concise and general manner, of the phenomena of "life" and "mind," in comparison with some occurring in the material world; by this means the thoughts are brought into better training, and the study of the phenomena resulting from the action of organism, which can be shown to be the vehicle or medium of mental action, is facilitated.

While upon these two former parts of our subject, we endeavoured to show the existence and operation of two imperceptible forces, and the necessity for the co-operation of organism for their manifestation; the various views that are taken as to the nature and properties of those forces have been discussed, and with regard to "life," the general conditions necessary for its manifestation were pointed out, and how far it could be considered as an entity and studied as such: in the second part, mental phenomena in general and those of the human mind in particular, with some general laws which regulate mental and instinctive actions, were mentioned; we are now in a condition to proceed.

MENTAL ORGANISM.

A. *The conditions necessary for mental manifestation.*

The term manifestation is meant to refer to those phenomena of mind that we are conscious of and can observe in others, in contradistinction to those which may occur without the existence of the body. For the manifestation of the vital phenomena in general which have been already spoken of, we saw that what is called organic structure is necessary, in connection with certain complex conditions; this structure we described briefly to consist of different component parts, fluids and solids, as well as different kinds of each; but it remains to be stated, that in addition to such general conditions of structure, certain particular and special arrangements exist in certain parts of the higher animal body, *e. g.* the heart, the lungs, the stomach, liver, kidneys, brain, &c., which, although different in their structure and form, yet derive their substance from the blood formed by the digestion of the food, to which we alluded when speaking of vital operations. It is not in accordance with the intention of this work to enter into the explanation and description of all these structures, for the task would be too great, but only to state, that each is necessary for the performance of a regular

and allotted function, and that the peculiar structure we are enabled to observe in each organ by means of the most minute and microscopical anatomy, is specially adapted to the performance of that function and no other; the structure of the liver is designed for the secretion of the bile, that of the stomach for the secretion of the gastric juice, the parotid gland for secreting the saliva, &c.; but the liver could not be made to secrete the gastric juice, nor the stomach the saliva, while the proper and normal conditions of the structure existed; in certain cases of disease, however, in which the vital properties of the tissues are deranged and altered, we find strange effects occurring: these organs may even deposit mineral substances and other morbid and misplaced productions within their tissue: the point to be remembered is the general adaptation of structure to function.

Now, in accordance with this grand principle, it is found, that for the performance of all the functions of life proper organs exist, and for the maintenance in action of vitality a general arrangement of structure and mutual assistance of parts is necessary; such conditions being provided for the manifestation of "life," it is both natural and proper to expect that the principle of "mind," the existence and operation of which has been proved, should be equally dependent upon organization; and since certain conditions of structure are necessary for the one, is there no particular structure possessed of peculiar properties designed also for the other? This question we proceed to examine in the following section.

The brain and spinal cord, with their prolongations, the nerves, are highly important organs in all animals in which they have been discovered; these centres of the nervous system, as they are called, are highly necessary to life; an injury to them is attended with the most serious consequences, and is very often followed by death.

It has been proved by Sir C. Bell and many others, that the spinal cord of all animals is an organ of voluntary motion and sensation: but neither of these functions is performed without the brain, nor can the brain alone perform them; *e. g.* if a nerve be separated from the cord, all power of motion and sensation is lost in the parts supplied by the nerve below the point of division; but both motor controul and sensation, remain in the parts supplied by the upper portion of the nerve which is connected with the nervous centres; thus it may be said that the "will" and perception of sensations reside in the cord as much as in the brain; but this is not admitted, for we find that if the cord be severed from the brain, neither the one nor the other occurs; therefore we conclude, that the integrity both of the brain and cord is necessary for the combined operations of sensation and voluntary controul; but that the voluntary and motor power reside in the brain, as well as the power or faculty of sensation proper; the spinal cord being considered as the medium for transmitting the effects of these functions, for an impression is not conveyed to the brain, and consequently does not produce a sensation, unless the spinal cord is entire from the point of impression up to the brain.

Arguments concerning the brain as the organ of mind.

1. *From comparative anatomy.* When we compare the brain and cord in man and the lower animals, we do not find so much difference as regards the spinal cord when compared with that of man, as we do between the brains of man and lower animals. According to Soëmmering, the adult brain is nearly twice as heavy as that of a horse, which weighs 1 lb. 7 oz. The weight of the human brain is found to be absolutely greater than that of all the lower animals, except the elephant and whale. Cuvier represents the proportionate size of the brain and medulla oblongata in man as 1 to 7; Chinese monkey, 1 to 4; short-tailed macaque, 1 to 5; dog, 6 to 11 or 3 to 8; horse, 8 to 21; sparrow, 7 to 18; owl, 14 to 35; dolphin as 1 to 13, being the highest proportion; the low numbers represent the medulla.

The relative proportion of the spinal cord to the brain in man is about as 1 to 33. This becomes less as we descend the scale of the vertebrata, until at length, in the cold-blooded animals, the spinal cord becomes heavier than the brain; thus in the mouse the weight of the brain to that of the cord is as 4 to 1, in the pigeon as $3\frac{1}{3}$ to 1, in the newt only as $\frac{5}{9}$ to 1, and in the lamprey as $\frac{1}{75}$ to 1. In comparison with the body, the spinal cord in man may be stated in general terms to be much smaller in man than it is in lower animals, but this has not been demonstrated in reference to the larger mammalia. *(See Quain and Sharpey's Anatomy.)*

M. Leuret has found, from extensive observation, that the proportionate weight of the brain to the

body, in the four classes of vertebrate animals, may be represented by the following numbers:

In *Fishes* as 1 to 5668 *Birds* . . 1 to 212
Reptiles . 1 to 1321 *Mammalia*. 1 to 186

In the Chimpanzee, the proportion is to body as 1 to 100. *(Owen.)*

In man the relative weight of the encephalon to the body was found in a series of 81 adult males to be as 1 to 36.5, and in 82 females as 1 to 36.46; these were taken from cases dead from disease of other parts of the body. The proportionate weight is greater at birth than at any other period, being about 1 to 5.85 in the male, and 1 to 6.5 female; the proportion diminishes up to the tenth year, being then about 1 to 14; from the tenth to the twentieth it is most striking, being then about as 1 to 30; after this period the general average of 1 to 36.5 prevails, with a further trifling decrease in advanced life. *(Quain and Sharpey.)*

The differences between the brain of man and that of the lower animals are not found so much in those parts devoted to the bodily powers, as in those which are allowed to be the seat of the strictly intellectual powers of mind, viz. the hemispheres of the brain; in accordance with these facts, we all know that man is distinguishable from animals beneath him in the scale, more by his intellectual than his bodily powers; and it is clear, that if we find any part of the brain preponderating in so remarkable a manner as the hemispheres do, we should expect to find such a conformation connected with "the peculiarities of man," of which the possession of intellect is certainly the most remarkable: again, we may pursue a similar method of argument by observing

the differences in the amount of brain in extreme cases amongst the human species: in comparing the brain of an idiot with that of Cuvier, differences are evident; the general proportion of brain is less in the idiot, and the deficiency is in the hemispheres; also in the cases of children born without any brain, in which none but the brute qualities are exhibited; so that development of the hemispheres is a grand feature in the physiology of the human brain, and to this we are to look as a source of the intellectual superiority of man.

The following, taken from Quain and Sharpey's Anatomy, involves such interesting matter, that we quote it nearly entire.

"According to tables formed upon observations by Clendinning, Sims, Tiedemann, and Reid (Dr. John), the average weight of the human brain has been ascertained in males and females, from the age of twenty-one upwards, to be in 278 males from 46 to 53oz., or 49½oz. avoirdupois, and in 191 females from 41 to 47oz., or 44oz., the average difference between the male and female brain being from 5 to 6oz. Tiedemann found the new-born infant's brain to weigh 14¼oz. to 15¾oz. in the male, and 10oz. to 13¼oz. in the female.

"The maximum weight of the adult brain in this series of 278 cases was 65oz., and the minimum weight 34oz.; in the series of 191 cases the maximum weight in the adult female was 56oz. and the minimum 31oz. The difference between the extreme weights in the male being 31oz. and the female 25oz.

"The maximum weight is reached between

thirty-one and forty years of age, it afterwards diminishes; anatomists have differed considerably in their statements as to the period at which the brain attains its full size, and also as to the effect of old age in diminishing the weight of this organ. Soëmmerring concluded that the brain reached its full size at the third year; the Wenzels and Sir W. Hamilton at the seventh, and Tiedemann and Reid between the seventh and eighth; Gall and Spurzheim that it continued to grow until the fortieth year. From the tables of Sims, Tiedemann, and Reid it appears that in general the weight of the brain increases rapidly up to the seventh year, then more slowly to between sixteen and twenty, and again more slowly to between thirty-one and forty, at which time it reaches its maximum; beyond this period there appears a slow but progressive diminution of about 1 oz. during each successive decennial period: the general results are the same in both sexes."

The proportional weight of the lesser brain to the cerebrum is in the male as 1 to $8\frac{4}{7}$, in the female as 1 to $8\frac{1}{4}$; in the new-born infant the ratio is strikingly different to what it is in the adult, being from 1 to 13 to 1 to 26 (Chaussier), and as 1 to 20 by Cruveilhier.

It has also been determined, that the weight of the cerebrum, as compared with that of the cerebellum, is greater in man than in lower animals, and that the brain of man is larger in proportion to the nerves connected with it than in lower animals.

But we proceed to speak of another set of arguments concerning the mental functions of the brain, viz.

2. *Those founded upon the effects produced on the brain, either by disease or external violence.*

A. *Functional effects.*—Like the other organs of the body, the brain may suffer, without its structure being necessarily altered, *i. e.* its ordinary *functions* may be excited or depressed; yet the injury caused by alteration of the structure is attended by somewhat similar effects. The simply functional effects we shall consider under the head of stimulus; the structural effects it will be more suitable to speak of under the head of injury to the tissue of the organ.

a. Stimulus. 1. *The blood* is the natural stimulus of the living structure; if it be either taken away, or applied in too large a quantity, the functions of the part thus acted upon are disturbed; if we bleed a person sufficiently he loses his senses, and every one knows he would soon die, probably on account of the want of this stimulus in the brain: if the blood be sent to the brain, so as to produce too copious an application of this stimulus, we have all the effects of excitement of its functions, such as quickness of thought, delirium, madness, furor, and inflammation supervening. In children we usually see great quickness of thought, which results chiefly from the important organic operations going on in the brain, and requiring the presence of a large quantity of aerated and nutritious blood which necessarily stimulates the organ. During a paroxysm of anger nothing is more common than to have apoplexy occurring; the anger may be the cause of the apoplexy, from its accompanying excitement of the nervous system and increased action of the heart; or there may be first of all an increased action of

the brain, arising from increased stimulus supplied, which disposes to irritability and anger, inducing the ulterior condition of apoplexy. The complete circulation of the blood through the brain may be prevented by various means, in which cases the function of the brain is performed in a more or less imperfect manner, the mind being confused, and the action of thought rendered more difficult than is natural; in death by inhalation of poisonous gases the extreme of this effect is seen, the intense lethargy produced being deadly and irresistible.—2. *Exercise* of the organ, which is a proper and natural stimulus to all structures, when carried beyond a proper extent, as by prolonged and intense study or incessant occupation of the mind, is accompanied by serious derangement of the brain, even so far as to produce inflammation and mania: intense sorrow, and even anxiety of mind also are equally productive of injury. Sometimes persons naturally dull and stupid have become quite bright, and capable of superior mental exertion, on account of a course of education and exercise of the mind, an effect which may be due to a stimulated condition of the brain, or other alterations in its condition; sometimes this effect is evidently the result of a stimulant, as during intoxication; sometimes the singular anomaly occurs of an improvement in the intellectual powers by a concussion of the brain.

So much for the effect of natural stimulus.—3. *An unnatural stimulus*, such as alcohol, ether, opium, gases, &c. applied, causes excitement of the mind, as we say; the mode in which these agents act is a subject for investigation; many act on the

heart, no doubt, and thus produce their effect indirectly by over supply of blood to the brain, while some perhaps act topically upon the structure by their actual presence in the blood, applied as ordinary nutriment or pabulum; in proof of which, Dr. Percy has detected the presence of alcohol in the ventricles and substance of the brain. (1839.)

B. Structural effects. Destruction or alteration of the tissue or structure of the brain.—1. Any thing which produces compression of the substance of the brain, or which diminishes the integrity of the organ, influences the manifestation of mind; a blow produces such a concussion of its particles as totally to suspend the mental operations. If compression of the brain is kept up, all mental manifestation is perverted; this will occur in various ways, as may be easily supposed, either by pressure of a fractured and depressed portion of the skull, or by a deposit of any kind upon the surface or in the texture of the brain, of any foreign and additional substances which tend to diminish the capacity of the skull; by effusion of blood or other fluid into the cavities or tissue of the brain, and by excessive supply of blood contained in the vessels.

2. *By abstraction from the general mass of brain.* Experiments upon lower animals have proved, that when we cut off a portion of each hemisphere of the brain in a living animal, the mental functions are deranged; when all that part of the general mass of the brain has been removed, that could be without destroying life, the animal has remained for a long time alive, but exhibiting none of the mental phenomena, lying in a torpid state, or as the gentle-

man who performed the experiment upon a pigeon expresses it, " in a sleep without dreaming."

In accidents and operations in the human subject, surgeons often meet with cases of injury of the brain from external violence. A man receives a blow which knocks a piece out of his skull, and the brain protrudes; such a portion is frequently cut off or lost by other means without any injury to the mental faculties of the patient, provided the brain which has been lost does not include particles from *both hemispheres*, when the mind would be affected: this is a very remarkable and important fact, and particularly to be remembered. One would suppose that the loss of a portion of the brain must be accompanied by loss of mental faculty, but we find by experience, that provided there has been no general injury to the organ, and the loss of substance is confined to the one half of the brain, no effect is perceptible upon the mind.

It may be worth while to mention, that we may by attention be conscious of the brain being in some manner in action during thought, and especially when the subject occupies our minds intensely. We know that when suffering from headache, any exercise of the mind causes an increase of the pain; and frequently we may perceive headache gradually coming on, as we have pursued any course of intense thought. This furnishes an argument from every one's personal experience, that the brain is the organ of the mind.

But having said thus much in undeniable proof that the brain is the organ of the mind, it remains to be stated that, although it be so, yet it does not

follow as a necessary consequence, that the mind cannot occupy any other part of the living body. We must be careful on this point, because we can easily understand that the brain may be the allotted instrument of the mind, and the only one by which it can be manifested, and yet the mind, like life, may pervade every part of the living structure. This is rather an abstruse question, however, and perhaps of no great importance for our present subject, yet it is necessary to admit it, in order that certain occurrences in the animal frame may be accounted for, though it is a question which cannot be proved satisfactorily either way.

The philosophy of the human mind has usually been dealt with by men of profound thinking powers and great reading, men accustomed to labour with their thoughts day after day: but few of these have received a medical education, and although some late writers display considerable acquaintance with the physiology of the brain, yet they appear to have handled their subject too much as a matter of subtile thought only, and without sufficient attention to facts of physiology and pathology; at that time, however, the anatomy and structure of the brain was not so well understood; had it received as much attention then as has since been paid to it, its importance to the study of the physiology of the mind would not have been so far overlooked. Within the last twenty years considerable progress has been made in the physiology of the brain and nervous system in general, and it is with a view of turning this to some good account in reference to psychology, as well as to complete

our view of mental phenomena, that we enter upon the study of the anatomy of the brain.

In the following brief account, we shall endeavour to give the general reader a description of the human brain, more especially of its external surface and form, its structure, composition, &c., divested as much as possible of technicalities, and without referring to every portion of the organ which has received a name at the caprice of anatomists.

Of the anatomy and minute structure of the brain and spinal cord.

I. *The brain.*

Description of the human brain.

We have already spoken of the importance of this organ to the general economy of life, and to the functions of relation, as they are called, and being an organ of exceedingly delicate structure, we should expect to find it carefully protected from injury, which is the case in a remarkable manner; it is completely enclosed by the skull, closely applied to its surface, which by its strength as well as mechanical form, serves greatly to protect the contents from injury.

Many persons suppose that the skull is not entirely filled by the brain, but it must be understood, that in a healthy condition nothing intervenes between the inner surface of the skull and the surface of the brain, but the membranes enclosing it, which occupy an exceedingly thin space, and do not prevent the inner surface of the skull from being a tolerably fair representation of the general shape of the brain, although of course the outer surface differs very much from the inner,

in being much more uniform; the form of the base of the brain cannot be ascertained from inspection of the external part of the base of the skull.

If the dome of the skull be carefully removed at a line extending around it, a little above the roots of the ears and the ridge of the eyebrows, and pretty low down behind, we then get a good view of the brain covered by its strong membrane; we observe that it completely filled that part of the skull which is removed, as it does that which remains.

Let us, for the sake of avoiding a very scholastic description, now suppose that we have carefully deprived the brain of its membranes, and removed it from the cavity of the skull; placing it in the natural position, we look upon it vertically; it is then observed, that the anterior part is considerably narrower from side to side, and altogether smaller than the posterior; its general shape would however be called ovoid.

We observe, passing across the organ from before backwards, and dividing it into two parts, a *deep fissure*, called the *great median fissure;* this cleft of the brain would completely divide it into two parts, were it not that at the centre the hemispheres are united, at a considerable depth from their surface, by a large band of branular matter; thus, however, the brain is in a great measure separated into two great halves, called the *hemispheres.*

But the surface of the brain is not plain and smooth, it is rendered unequal by many elevations and depressions, as if here and there a portion had been pushed inwards, and the sides at the same time

compressed together; this appearance has been well compared to the effect of compressing any spherical case containing a yielding bag, the surface of the bag becomes puckered inwards in every direction in order to occupy the diminished space; these are called the *convolutions;* they are composed of an important part of the brain, and are seen over the whole surface of it; some are, however, concealed from view. On comparing those on the one hemisphere with those on the other, we observe a general resemblance between them; *i. e.* we may find a furrow, running in a longitudinal direction, corresponding to one on the other side. But there is no exact symmetry between the convolutions of each hemisphere, and their size varies in different places. These convulsions are called "*gyri;*" and the furrows between them, "*sulci.*" The depth of the sulci varies, being about 1 inch to 1½. There is one long convolution always found, just above the corpus callosum, in each hemisphere. Other particular convolutions have been traced also, both in man and lower animals, as occurring pretty generally, though not in precisely the same spot in the brains of different animals, still identical and regular in form and appearance. *(Leuret, Anat. Comp. du Sys. Nerv.)*

We have described the general shape of the hemispheres as ovoidal. It will be understood that each one is flattened at the side in contact with the other, thus forming one half of the ovoidal form.

Let us now reverse the position of the brain and observe its base. The general form of the under surface is much more irregular, and less convex. On each side of the middle line corresponding to

the great fissure alluded to, and about the middle of the under surface of the hemisphere, we see a large projecting portion, called a lobe, upon each hemisphere, "*the middle lobe.*" A little posteriorly to these, and placed across the middle line, we see a very prominent white looking part, called the "*tuber annulare,*" or "*pons varolii,*" "*cerebral protuberance,*" &c.

But now we observe that the posterior portion of the hemispheres is completely hidden; for, before they are come at, we have to remove a large mass of brain connected with the protuberance just referred to, and in the present position of the brain, lying upon the posterior part of the hemispheres, this important portion is called *the lesser brain* or *cerebellum.* Its shape is somewhat circular and flattened. It is composed of two lateral lobes, separated in a great measure by the median fissure before spoken of. Its surface is different from that of the great brain, being covered with sulci, forming layers, which are again divided by smaller sulci; thus, we might say, it was made up of compound lamellæ. At various points of the brain nerves are given off.

So much for a rough outline of the brain. But it has been stated repeatedly that this organ is intimately connected with the spinal cord; in fact, that the two act together, as the centres of the nervous system.

We therefore proceed to speak of their connection one with the other.

II. The Spinal Cord.

Before we could take out the brain from the skull,

into which it so nicely fits, we were obliged to cut through a portion of branular matter, which seemed to arise from the general mass of the brain and pass down through the spinal column;—this is the spinal cord. On looking at the brain before us, we see that about an inch and a half of this cord has been left attached to the brain; this is usually called the "*medulla oblongata*," a name given merely for the sake of enabling us to describe certain important parts, which are to be seen in that part of the cord. Let us now trace up this piece of the cord, and observe how it is connected with the brain. It passes into the body called the tuber annulare, and we see a large portion of it going onwards and soon dividing into two portions, which pass one into each hemisphere; these are now called the "*crura cerebri*." The chief of the other portion of the cord passes in two divisions into the lesser brain, forming what are called the "*restiform bodies*," or peduncles of the cerebellum.

The spinal cord is continued down the vertebral canal as far as the first or second lumbar vertebra. It is partially divided into two grand portions or columns by two median fissures anteriorly and posteriorly, in a manner somewhat parallel to that in the brain, the complete division being interrupted by a portion which unites the two columns. These two halves of the cord are again subdivided by other fissures, forming the lateral columns. Throughout the whole course of the cord, pairs of nerves are given off, one nerve from each side, by two roots, the one posterior, the other anterior, which unite, at a certain distance from the cord, to form a com-

pound nerve; the point of juncture being marked by a small nervous enlargement called a ganglion.

The organs just described are copiously supplied with blood, and nothing strikes the observer more than the extraordinary number of blood-vessels covering every portion of the brain and penetrating its structure; so much so, that an inexperienced person might suppose the organ was in a state of perfect apoplexy, from the number and fulness of the blood-vessels.

The internal anatomy of the brain.

If we take a slice off the hemispheres in a horizontal direction, we expose the tissue or structure of the brain; we observe that it is composed of two kinds of matter, which differ in appearance. *The white matter* occupies the central part of the hemispheres, and forms the greater bulk of the brain in general; *the grey matter* is seen at the periphery of the organ, varying somewhat in thickness, and inclosing as it were the white matter.

If we endeavour to separate the two hemispheres at the middle line corresponding to the great fissure, we find they are connected strongly by means of a large mass of white matter, extending for about three inches from before backwards, its anterior end being nearer to the border of the hemispheres than the posterior; it is thicker at its posterior than its anterior part; the ends are rounded and bent upon itself somewhat, but are connected with other parts in a peculiar manner.

This part is called " the great commissure" of the brain, " the mesolobe," " the corpus callosum;" it is of great importance, and serves as the grand

means for the united action of the hemispheres. If we proceed to slice away the hemispheres and the body just described, we come to *a cavity or ventricle* of a peculiar form in the centre of each hemisphere; in early fœtal life they were of regular ovoid shape, corresponding to that of the hemispheres, but after birth, and in the adult condition, their shape is peculiar, and does not correspond at all to that of the hemispheres; these lateral ventricles, as they are called, are separated by a delicate partition of cerebral matter in two layers, forming a double partition, and inclosing another ventricular space.

At the lateral ventricles, forming one of their boundaries, and situated at the body or central part of the ventricle, are *the corpora striata*, bodies of a pyriform shape, placed with the broad anterior ends almost in opposition, while the posterior and narrowed extremities are separated to the extent of an inch and a half to two inches, thus sloping from within outwards; the superior surface which projects into the cavity of the ventricle is smooth and convex; the other part is embedded in the substance of the hemisphere; they are called striated bodies, from the appearance seen upon their cut surface, the external surface being composed of grey matter, the inner of white and grey intermingled, in bundles.

Behind and between the corpora striata are seen the *two thalami optici*, white bodies, of somewhat oval shape, lying with their internal surfaces in opposition, and in part united; their superior surface projecting into the body of the ventricle, and their posterior and inferior surfaces forming the roof of the descending corner of the ventricle, while their

external surfaces are blended with the corpora striata and substance of the hemispheres; a small space exists between the contiguous surfaces of the thalami, called the third ventricle. These parts have intricate relations to other important parts in their neighbourhood, but which we refrain from describing here, lest the general reader should lose sight of the parts now described, in the maze that would be created, if other objects were fully described; our aim is to give a general notion of the brain, for as we have said when entering upon this subject, the true idea of the brain cannot be conveyed by the study of words alone: he who wishes to understand its nature at all, must dissect brain after brain, and study every one patiently.

Looking at the vertical section of the brain, we observe the fornix, a part beneath the corpus callosum, passing from before backwards and connected with the corpus callosum anteriorly and posteriorly, in fact it seems as if formed by the reflected ends of that body; it is described as a triangular lamella of white matter; it is parallel to the corpus callosum, separated from it by the vertical partition called the septum lucidum.

The anterior end of the *fornix* is the narrower one, and divides into two pillars, which curve downwards at the fore part of the third ventricle, and pass to the base of the brain, where they make a peculiar double and become the *corpora albicantia*.

The base or posterior end gives off at each angle a thin flat process, which passing into the descending corner of the ventricle, is then called the *corpus fimbriatum*.

The under surface of the fornix overlays the thalami and third ventricle, separated from these however by a portion of the arachnoid membrane lining the ventricles called the *velum interpositum.*

The commissures.—There are several very important parts of the brain which from their uniting, as it were, one part with another, are called commissures; viz. the great commissure or corpus callosum, the anterior commissure, the posterior commissure, the soft commissure uniting in some measure the optic thalami, and the optic commissure; other parts of the encephalon are somewhat analogous, inasmuch as they appear to be adapted to the same end, viz. the *tuber annulare* uniting the hemispheres of the cerebellum, and in the medulla oblongata the *pyramidal decussation*, forming an interchange of fibres between the columns of the cord; in the cord itself we have the central grey matter uniting the two columns throughout their whole extent.

As to the locality of the commissures in the brain.

The great commissure or corpus callosum, has been before described.

The anterior is situated in front of the fornix passing in the form of a delicate fasciculus across from one corpus striatum to the other in which it is embedded; *the posterior passes* from one thalamus to another at the posterior margin of the third ventricle, and its ends are lost in the thalamus of each side: *the soft commissure* is a delicate layer of grey matter, uniting slightly the two thalami. *The optic com.* is a simple sudden blending of the fibres of the optic nerves in their course to the eye, composed

of fibres crossing from one nerve to the other, and of others proceeding more directly on without crossing over.

The internal anatomy of the lesser brain.—Of the general appearance of the cerebellum we have already spoken, we have now to treat of its parts. The relative weight of the cerebellum to that of the cerebrum is as 1 to 8. The hemispheres are separated behind by the median fissure, and in front by a deep excavation which lodges the medulla oblongata, a kind of rounded ridge runs at the middle line from before backwards, called processus vermiformis superior. *The lamellæ* which corresponds to the convolutions of the cerebrum, are about from 60 to 70 in number on the upper surface, and pass horizontally round each hemisphere, aggregated into 5 fasciculi.

The cerebellum is connected with 3 pairs of fasciculi; from the interior of the hemispheres, two fasciculi pass forwards and upwards, converging towards the lower pair of tubercula quadrigemina, these are called the *superior peduncles.*

The inferior peduncles are two white rounded processes seen to pass from the medulla oblongata obliquely upwards and outwards into the hemispheres of the cerebellum one on each side, they are named also posterior pyramids as parts of the medulla oblongata.

The middle peduncles are continuous with the fibres of the tuber annulare, the right and left ends of which we have seen are lost in the corresponding hemispheres of the cerebellum. They are the largest and in conjunction with the pons Varolii correspond to the corpus callosum of the brain.

Appearance of the substance of the cerebellum; if a vertical section of the cerebellum be made at a line one-third of the breadth of the hemisphere from the middle line, an oval portion of grey matter will be exposed, called the *corpus dentatum*, from its border being notched; this corpus dentatum may be considered as a bag open at one end, the centre of which is occupied by white matter forming an appearance like a tree, "*the arbor vitæ;*" the white matter being enveloped as it were in the grey matter of the laminæ has also an arborescent appearance.

The cerebral protuberance synonymous with "nodus cerebri,"—"pons Varolii;" "tuber annulare," has been before mentioned, but requires a more minute description, its relative size to the whole encephalon is as 1 to 72; in shape it is somewhat square, its *anterior surface* presents no appearance of any importance to our subject, but on its posterior surface which is overlapped by the cerebellum are seen four rounded bodies, the *corpora quadrigemina*, in pairs, one above the other, and separated by two decussating lines, the upper pair is the largest; upon these corpora quadrigemina is seen the *pineal gland*, a small conical body of a deep grey colour, placed with its narrow part or apex forwards, it is connected to the parts in its neighbourhood, and on each side of it runs a little white band to the optic thalamus, it thus seems to be seated upon the corpora quadrigemina, and from the appearance of the two bands running from like reins has been called the charioteer. Its use is quite unknown, the celebrated Descartes conjectured it to be the seat of the soul; it is erroneously called a gland for it is not

of a glandular structure, it is hollow and often contains phosphate of lime in the form of small grains of sand.

Another small body remains to be noticed—*the pituitory body.* In front of the corpora albicantia situated upon an eminence of grey matter it is to be seen, a small yellowish body formed of two lobes—the anterior one larger than the posterior; this little body is solid in structure and connected to the grey eminence by a small tubular process, the infundibulum, it is rarely seen attached to the brain, because it is embedded closely in a part of the skull, and when the brain is taken out, the infundibulum is broken across leaving the pituitory body in its little case.

We have now to speak of the manner in which the cerebral matter forming the parts just described is arranged, or *the minute structure of the brain.*

Although the precise arrangement of the fibres forming the brain is not clearly made out, yet we are able to give a very tolerable description of the structure which forms the mass of the brain. This subject was studied by the early anatomists, and afterwards by Varolius and Vieussens, who appears to have been the first who attempted to show the fibrous structure in the fresh, as well as the indurated brain; see his Neurographia Universalis, published 1684; but not with so much success until Reil, the German, made his dissections of the brain, of which he wrote descriptions, first in Gren's Journal der Physik. 1795, Leipsig, and subsequently in the Archiv. für. die Physiologie, 1807—1812, Halle. He was enabled to dissect the brain much better

by using means for hardening it, such as boiling in oil, soaking in alcohol or nitric acid, &c.; his work is, we believe, not yet translated, but Mr. Mayo has made the dissections that Reil recommends, and has illustrated them with some of the best drawings ever made of the brain. Vicq. D'Azyr also made some accurate and minute dissections of the brain with good descriptions of the parts to be seen. Then came Gall and Spurzheim, who entered most vigorously upon the subject, with a view to supporting their doctrine of phrenology. They wrote a very extensive work, embracing a great deal of useful matter, but full of course with phrenology, with the exception of the first part, which contains all that the anatomist wishes to read. The merit, however, of this work consists more in its confirming, by numerous dissections, the researches of their predecessors than in any discoveries of parts or structure. It is, therefore, a work of authority as to the structure and anatomy of the brain, although it contains so much of hypothesis as regards the functions of the organ.

Even in the present day, popular lecturers have described the brain as like "hasty pudding," or "hotch potch," devoid of arrangement; but if we reflect upon the general beauty and intricacy of the minute structure of the tissue of all organs, how little there is to lead us to speak thus of the structure of the brain, even though we did not know any thing to the contrary.

The white matter of the brain is described as "a soft tenacious pulp;" but it is easily shown to be fibrous. When boiled in oil, or hardened by spirit,

it may be torn into lamellæ, the surface of which appears marked in lines: these lamellæ are composed of delicate fibres.

The fibres forming the white matter are not to be found shooting in every direction indiscriminately, but are arranged in laminæ or plates, and in some places in bundles. These are reducible to the very minute or ultimate fibres or filaments, which Ehrenberg, the well-known microscopist, describes as tubes about the $\frac{1}{4800}$ of an inch diameter, here and there dilated and filled with a pellucid fluid. It is, however, denied by Valentin and Dr. Sharpey, that they are tubular at all; so that this is an open question. The fibres do not unite one with another, but are always distinct.

The grey matter; syn. "cineritious," "cortical," is of a firmer texture rather than the white and more gelatinous appearance; some have considered it fibrous, but this is denied by Gall and Spurzheim, and by other observers. Ehrenberg says it is composed of smaller tubes, which are not varicose or dilated here and there, and that numerous little round bodies are to be seen amongst them which he thinks correspond to the blood nuclei, but, probably, this is incorrect; this structure is not considered to be fibrous at all by Valentin and many anatomists, who find that it is composed of globules similar to those of the ganglia; whether these are connected, and if so, in what manner, is yet to be made out. Reil says it is composed of irregular lamellæ of fibres uniting at various angles, and that the fibres are arranged in a radiating manner in each lamella like those of a hair pencil.

There is no doubt of the importance of the grey matter to the functions of the brain, it is much more supplied with blood than the white matter, and we have before remarked, that at the junction of the roots of all the spinal nerves a little mass of grey matter is found, which would also denote its importance; it is also found in several parts of the brain which are of importance, as the corpora striata, corpus dentatum, corpora olivaria, and at the origin of all the nerves: it is frequently in the form of a bag or capsule. The bodies called ganglia, seen upon the spinal nerves and others, are of a similar colour; they are classified by some writers along with the various parts of the brain we have described, *e. g.* corpora striata, thalami optici, corpora quadrigemina, &c. and considered as "subsiduary brains, affording independent sources of nervous power, and constituting a number of minor seats of sensation;" but this view is by no means satisfactorily founded.

Arrangement of the fibres of the brain and cord.

The spinal cord is, like the brain, composed of fibres, and of central grey matter of a peculiar shape; these fibres are, as in the brain, quite distinct one from the other, having no lateral joinings. Supposing that our dissections were made with sufficient accuracy, we might be able to trace a fibre from the cutaneous end of a nerve to the cord, up the cord, through the medulla oblongata, and thence to the brain; this being understood, let us now take up the dissection from the medulla oblongata.

A. *The fibres of the cerebellum.*

The exact connection of the fibres here is not made out, but we are able to demonstrate three sets of

fibres belonging to the three pairs of crura, which are more or less connected with the middle of the cerebellum.

1. *Those of the middle crus or commisural fibres, which form the tuber annulare,* can be traced into the most external of them.

2. *Those of the inferior crus,* which come from the corpus restiforme, can be seen to pass to the laminæ, but chiefly to the middle portions of the hemispheres.

3. *Those of the superior crus* are found to arise chiefly in the corpus dentatum at the centre of the hemispheres, some probably coming from the laminæ.

The distribution of the fibres in the laminæ and their leaflets is peculiar; some pass around each leaflet from one to another; others pass along the laminæ, leaving the leaflet.

B. *The fibres of the cerebrum.*

These are also referable to three orders.—1. Diverging fibres; 2. Converging; 3. Longitudinal uniting fibres.

1. *The diverging fibres.* These are called also the peduncular fibres, because they form the crura cerebri; from the anterior pyramids of the medulla oblongata, the lateral columns of the cord or sensory tract of Bell, and corpus olivare, we trace them through the tuber annulare, after leaving which they are called the crura cerebri; here they receive some additions, in the fillet of Reil, a small band from the medulla oblongata, the superior crura of the cerebellum, and those from the corpora quadrigemina; the whole body then pass forwards through the

thalami optici, and a large portion through the corpora striata to the substance of the hemispheres, where they spread out in a peculiar manner, the most anterior fibres retaining their position, and passing more forwards than those behind them, which pass into the posterior and middle lobes of the brain.

2. *The converging fibres.*

These form a very large body; they appear to reach from the convolutions of one hemisphere across to those of the other, and form the corpus callosum; they decussate with the other fibres. The anterior and posterior commissures and the valve of Vieussens are classed with these fibres. There is at present a difference of opinion as to them; the description just given is according to Gall, Spurzheim, and Reil; but Tiedemann and Foville state that these converging fibres are merely the continuations of the peduncular fibres, or those we have called "*diverging;*" now, if we consider the necessary direction of some of these commissural fibres, it will be evident that many of them, especially those coming from the posterior lobes, must, in order to be collected so as to form the corpus callosum, run parallel with some of the peduncular fibres, so that it would be very difficult to distinguish one fibre from another.

3. *The longitudinal uniting fibres.*

These are not so numerous and general as the other two sets; they are to be seen in several parts of the brain. Under the long convolution immediately above the corpus callosum, and upon the last-named body, a long band of these fibres is seen,

this has been called the fillet of the corpus callosum; the *fornix* and *tenia semicircularis* are also formed of these fibres. In addition to these, Mr. Mayo describes fibres passing from one convolution to another, as in the laminæ of the cerebellum, but anatomists are not sufficiently agreed upon this point. Having thus briefly described the fibrous structure of the brain, we will complete our account with a sketch of

The comparative anatomy of the human brain, and its condition in early fœtal life.

However well we may understand the structure and anatomy of the brain, we know but little, unless we have learned something as to its functions: to assist us, then, in studying the physiology of this organ, we are glad to avail ourselves of the aid which the study of the same organ in the lower animals affords: we cannot enter so fully into the subject as its interesting nature would entice us to do, we shall merely give a few instances from the lower animals by way of illustrating some general observations as to the functions of the human brain.

The proportional size of the brain to the whole body may in general terms be said to increase as we go from fishes and reptiles up to apes and man; in some mammalia it is equal to man, and in some birds it is greater; in man the proportion is as 1 to 28, in dogs as 1 to 160, in horses as 1 to 400, in the elephant as 1 to 500, in the canary bird as 1 to 14, pigeon as 1 to 91, in the Gibbon as 1 to 48, and the Simia Capucina 1 to 25. (*Carus, Vergleich. Zootom.*)

The weight of a human adult brain varies from

2lbs. 5½oz. to 3lbs. 1oz. 7drs., while that of a horse is in the maximum, according to Soëmmerring, 1lb. 7oz., and the brain of a whale, 75 feet in length, in the museum of Berlin, weighed 5lbs. 5oz. 1dr.; these examples show how great is the proportion of brain awarded to man.

External form.—On comparing the brain of a common fowl with the human adult brain, we see a great difference; the cerebral hemispheres, which in man overlap even the cerebellum, are in the bird much smaller in proportion, and do not cover the corpora quadrigemina even. In fishes the hemispheres are still smaller, and the corpora quadrigemina quite exposed and become larger as the hemispheres have lessened. Taking a general view of the brains of fishes and reptiles, we may say that they are subject more to a linear arrangement of parts, composed of double and single enlargements on each side of the median plane, or upon it. The great comparative size of the corpora quadrigemina in these animals must not be overlooked. Now it is found that, as we ascend the scale, the hemispheres are seen to increase in size, while the corpora quadrigemina decrease, the former encroaching more and more over the parts beneath them, until they cover them entirely, as in man.

It is highly interesting to find that the early fœtal condition of the human brain corresponds in great measure to that of the perfected fish, reptile, and bird; the parts do not overlap, and the hemispheres are much smaller than the other parts, appearing as small vescicles filled with fluid.

When we consider these facts, and compare the

amount of mental power possessed by fishes, reptiles, birds, and mammalia with the exalted powers of man, we are inevitably forced to regard the hemispheres as highly important parts, and connected especially with the mental and intellectual functions of the organ; to this point we shall again recur, when speaking of the effects of injuries and disease upon the brain.

Of the chemical composition of cerebral substance.

It is remarkable that the brain is found to contain a considerable proportion of salts, some sulphur, and phosphorus in a free state, as the following analysis shows.

Composition of Cerebral Matter. (Vauquelin.)

Water	80.0
Albumen	7.0
White fatty matter	4.5
Red ditto ditto	0.7
Osmazome	1.12
Phosphorus	1.5
Acids, Salts, and Sulphur . . .	5.15
	100.0

We have thus endeavoured to explain the general condition of the brain necessary for mental manifestation. From the infusory animalcule up to the highest human organization, we have traced the general fact of adaptation of structure to the function to be performed; with regard to the mental manifestation, we saw that it is proportional in great measure to the complete structure and development of the brain; from the lowest animals to man we saw that the brain continued to increase in relative bulk and complexity, up to the absolute

superior size in man; from this we argued the dependence of mental manifestation upon the brain; we mentioned also various experiments and observations that supported this view. In describing the brain, we saw that it is nearly divided into two large parts, the hemispheres, having their surface indented with furrows forming the "convolutions," which we saw increase in number as we ascend the scale of animals, and are greatest in man, with the exception of the dolphin. But we did not allow that these convolutions are of any importance to the mental action, for cases occur in which, by the secretion of fluid in the central cavities of the brain, they become destroyed, and the surface of the organ becomes smooth and unravelled, yet the mental faculties generally remain unimpaired. These convolutions must rather be considered of more importance as a means of protection, for by this arrangement as little as possible of the surface of the brain is exposed to injury from external violence. We said also that the integrity of both hemispheres is not necessary to the performance of mental action, that one, if entire, may perform complete mental action, so far as it is possible to judge. As to structure, it is necessary, in order to the due manifestation of mind, that the brain, as a whole, should retain the structure we have described, especially as regards the grey matter at its surface, but that an isolated portion on either side may be injured, without any loss or derangement of the mental faculty. But we now proceed to state more minutely the

B. *Circumstances that influence and modify mental manifestation.*

What we have to say on this subject must necessarily have reference to what has been said when treating of the conditions necessary for mental manifestation.

1. *As to the effects of different modifications of external form.*

The effect of general bulk of brain, in its proper condition, must be admitted, both on account of the arguments derived from comparative anatomy, and from comparison of the brain of the idiot with that of Cuvier, Dupuytren, or other large brain; and the head of New Zealanders, negroes, bushmen, &c. with the European or Caucasian head. In these instances a very evident difference is to be seen, consisting in a *general* defect or want of size, the whole mass of brain being less; but we remark that the deficiency is greatest as regards the upper and anterior portions, so in the negro and other similar races there is general smallness, and particular deficiency as regards the upper and anterior parts.

We have previously given the results of extended observation upon the prevailing weights of brains. Quain and Sharpey say, upon this subject, "all other circumstances being alike, the size of the brain appears to bear a general relation to the mental power of the individual, though instances occur in which this rule is not applicable. The brain of Cuvier weighed upwards of 64oz. and that of the late Dr. Abercrombie about 63oz. avoirdupois. On the other hand, the brain of the idiot is remarkably small; in three idiots, whose ages were sixteen, forty, and fifty years, Tiedemann found the weight of their respective brains to be $19\frac{3}{4}$oz., $25\frac{3}{4}$oz., and

22½ oz.; and Dr. Sims records a case of a female idiot of twelve years old, whose brain weighed 27oz."

In all these cases of low weight there is, as far as we are able to judge, an inferiority in mental manifestation: let us examine how this can be accounted for. With regard to idiots, the diminution in size arises from general deficiency of branular development, and a want of that proper and normal state of organization, which we know is only to be found in perfected organs, in consequence of which they are devoid of that perfection of function which can be performed only by the proper and complete state of organic structure. It is true that at present no grand difference as to the structure of the idiot brain has been made out, though we often find various appreciable differences, such as softness or hardness, but otherwise the structure is apparently the same as in others. It must be observed that the difference in the mental powers of the idiot is general, and not particular, being an example of general debility of function. The brain in the lower animals may be considered more or less parallel to that of of the idiot, the hemisphere being most defective in each.

With regard to the uneducated negro, bushman, and others, the same general differences exist, and are to be accounted for by the general effect of want of education; all structures are improved by the exercise of their proper and allotted functions, and so the brain. In the country peasants we may certainly see the general effect upon the brain, of lack of culture, and exercise of the mental powers, a manifest difference may be observed in the general

size of the upper and anterior portions of the head of the peasant and the artizan who has been bred in large cities; but to this subject we shall have occasion to refer again, when treating more especially of the doctrines of phrenology. It remains, however, to be stated, that high mental manifestation is not incompatible with a small head, for which we shall endeavour to account. Sometimes the brain is not symmetrically developed; one hemisphere may be larger than the other; in such cases it does not follow that the mind should be proportionably deformed, for often the faculties are unimpaired, *(Cruveilhier)*: rarely, the other duplicate or medial parts are either not symmetrical or abnormal in form. The convolutions are sometimes fewer or more numerous than usual, and Desmoulins says they are deficient in idiots. In rare cases the cerebrum has been found not divided into hemispheres, but Reil, Meckel, and Wenzel mention instances of more than the usual division, caused by the deficiency of the great commissure. The colour of the brain varies; the grey matter may be wanting, or it may be very pale, or very dark red, sometimes the brain becomes brown, orange, grey green, slate, and even black in places, *(vid. Otto*, 1830.)

In these departures from the normal structure, we generally find more or less affection of the mental powers.

2. *Effect of injuries to parts of the brain.*

This subject has received valuable additions of late years; experiments have been performed upon all the various portions of the brain, and we may consider that the general allotment of bodily function

to parts of the brain is pretty well made out; we could wish to detail every experiment that has been made, but this would require more space than we can afford, and it would be difficult for the general reader to understand the localities of the different experiments without considerable anatomical knowledge, we shall therefore be content with stating the whole subject in a very general manner.

It is proved by cutting away certain portions of the brain in a living animal, that there are parts particularly connected with the spinal cord which are necessary to the performance of voluntary motion and sensation, as when they are cut, or separated, or injured, these functions are not performed; they are situated at the base of the brain. Other important parts, also at the base of the brain, are necessary to life; *i. e.* to respiration and circulation: if they are destroyed, life is instantly destroyed. Experiments performed upon the lesser brain would lead us to consider it connected with the power of regulating the motions of the body: when this part was injured, strange effects were produced, the animal ran backwards or round and round, or rolled over and over; similar effects have been seen in a cobbler at Paris, who could not resist running round, and in whom, after death, the same part was found diseased. With regard to the hemispheres of the larger brain, which most concerns our subject, it is found that they may be sliced, and even wholly removed, without interfering with the vital functions of the animal; but if entirely removed, as far as their connection with the vital parts, the creature is entirely deprived of voluntary motion and sensation, unless these can

be said to exist when the creature made a few steps after being roused from its perpetual sleep; it becomes an intense idiot; no mental manifestation whatever is to be seen; yet still it lives; and M. Flourens found a pigeon live three months in this state, eating and drinking any thing that was placed in its mouth, and flying when thrown in the air: if one of the hemispheres was removed, the animal showed signs of debility and paralysis, but retained its sight and hearing on one side, as well as some mental manifestation; it is very remarkable that in all these experiments the creatures seemed to recover considerably from the first effects, especially when one hemisphere only was cut off, when they recovered their senses and power of moving about and did not appear uneasy. Now in man we find precisely similar results; we often meet with cases in which the effects here related are exhibited, but as regards the hemispheres the subject is not so clear. An accident that would remove much of the brain, would produce so much concussion upon the other portions necessary for life, as to leave no chance of any other effects being studied; it is indeed astonishing that so much injury is sometimes done to this organ without any effect either on the mind or the body. All kinds of foreign bodies have remained in the brain for a long time without inconvenience; amongst the most remarkable of thirty cases are, that of a sword point for 14 years; the point of an arrow, 9 years; the point of a sword, the whole life; two screws shot in, $21\frac{3}{4}$ years, without inconvenience; 40 large small-shot; and that of a man who walked 130 miles with a piece of a gunstock in his brain;

(vid. Busch in Petersburger Abhaudl, Part II. p. 215, 1823;) also that mentioned by Mr. Rogers, of a piece of a cannon carriage, three inches long and three ounces weight, being in the brain for 21 days, (*vid. Med. Chir. Trans.* Vol. XIII. 1827.) Instances are not uncommon in which a portion of either hemisphere has been removed without any change in the mental function; the surgeon does not hesitate to cut off any part protruding from a fissure in the skull, and generally no inconvenience to the patient arises; frequently, however, there is so much general injury done to the brain by the accident, that general debility or derangement of function remains; and often the most complete derangement of intellect follows. A wound causing loss of brain is generally healed by granulation, though sometimes brain is not re-produced, but it heals without; incised wounds and tears will heal by adhesion of their sides, *(Otto.)* So it is to be understood, that either half of the brain, being in a sound state, may, at least in a more or less perfect manner, perform the entire duties of the mind, while the remainder may be in a state of disease.

3. *Effects of structural changes.*

We have seen that the structure of the brain is composed of fibres which are tubular, and arranged in a regular order; the integrity of this fibrous structure is a necessary condition for mental function, and whatever tends to destroy it lessens the mental manifestation, and the capabilities of the organism. The structure of the brain may, by disease, become changed and altered from its natural state, in which case there is observed to be a difference in the mental manifestation; the mental power exercised is

less, or, if we may use the expression, the mind is manifested in a perverted manner, though sometimes all this effect is produced without our being able to perceive any alteration in the structure. Again, as frequently occurs, certain portions of the brain may become harder or softer, or changed altogether in their nature and composition, as in the formation of cancer and other morbid growths and deposits: in such cases it is not necessary that the morbid growth shall be additional to the encephalon, but if it occupy the place of sound structure, it interferes with the function of the entire organ, both by destroying the fibrous arrangement as well as diminishing the general quantity of brain; so that it is not necessary that these growths and deposits should occur outside the brain, or in any other way produce compression of the organ, in order to cause injury to the mental faculties. Cases have occurred in which important parts of the brain have been pressed upon *gradually* without any effect upon their functions *(Cruveilhier)*.

In such cases, where a portion of the brain is diseased, and its structure altered, we do not find a loss of any particular faculty of mind, the effect is rather a general one in regard to the function, so far as we can observe; *e. g.* if a portion of diseased brain exists at the top of the hemisphere, the patient exhibits, perhaps, stupor, loss of memory, judgment, and attention; these are general effects, and they occur in almost every case, especially as regards memory, the loss of which is by far the most common symptom. Very often tumours or other deranged conditions of structure are found in every part but

that to which is attributed " the faculty of memory," while this *faculty* has been most deranged by disease. Often the opposite to the general effect is produced; we may have a case in which there is a *general* diminution of mental power, almost an idiotcy, produced by *partial* injury to the brain. Upon this subject Dr. Copland has some excellent remarks:—" Of all the organs of the body, the brain is the most exquisitely and incomprehensibly formed, and presents the least intimacy of connection between the results of dissection and the phenomena of disease. The most violent symptoms referrible to this organ often exist during life, and yet on the most careful examination after death, either no appreciable lesion, or none sufficient to account for the phenomena, can be detected. Whilst, on the other hand, many and most important changes are frequently discovered in both the brain and its membranes in cases which betrayed either no cerebral disorder, or none calculated to excite suspicion during life of any organic change."—*See art. Brain, Dic.*

4. *Functional alterations.*

We have repeatedly alluded to the necessity of complete organic structure, for the exhibition of vital and mental phenomena in general; in no organ is this more necessary than in the brain; its influence over the entire system is very great and important, its sympathy consequently is very delicate, and easily excited by the various changes going on in the general system. The severest head-ache, which seems to the patient quite distracting, may be caused entirely by the presence of an irritant in the stomach; and disturbance of

the circulation exhibits its first effects upon the brain, in excitement or depression of the mind, as the case may be. Besides this, there is an energy or influence resident in the brain, which is, as we have seen, necessary to life and respiration, the latter function being closely connected with the brain. The brain, then, performs an important office, and at the same time is a structure highly susceptible of impressions, all which may be called its function. Now a derangement of function may occur, without any evident derangement of structure or any perceptible change in it, as is seen in those cases of insanity where no difference can be perceived in the brain from that of a sane person; we then call the effect functional, yet probably some minute and subtile changes in the particles of branular matter do take place, for we cannot conceive of insanity in any other way, but as dependent upon deranged organization. Of disease of the brain in insanity Otto says, "Those pathological conditions which we consider especially grounded in the nervous system, as mental and nervous disease, appear but in very rare instances, to have their primary seat in it." Esquirol, that in the examination of the bodies of 277 insane persons, he found but 77 with diseased structure of the brain; Pinel found 68 out of 161; Georget, not one half. Flourens considers that disease of the mind can only be caused by organic vices in the brain; according to Casauvieilh and Boucher, the medullary (white) substance is affected in epilepsy and catalepsy, and the grey in true diseases of the mind. The dynamic conditions of the brain, then, may be vigorous, or weak, or altered in their charac-

ter, without any apparent and evident alteration in the structure of the brain. It remains to be said, that we may find a very large brain in a man of strong body and healthy constitution, the structure of which shall be apparently the same as that of other normal brains, yet in this man the mental functions are so weakly performed, that even almost imbecility may exist; it is equally important to remember that the reverse constantly occurs, a small brain capable of showing the highest mental phenomena and activity. This does not depend upon the relative supply of blood, for we find that very nearly the same quantity of blood fills the brain at all times, provided the structure of the vessels and of the brain remains entire, and the quantity of fluid in the ventricles the same, in consequence of the skull being a closed cavity. It will be found on examination that, generally speaking, persons distinguished by their talents possess rather a small than excessive amount of brain.

It must be evident that the physiology and pathology of the brain is not so well understood as some wish to show; phrenologists tell us that "other things being equal," size or quantity of brain is proportional to the faculty displayed; but this is not correct, and not at all in accordance with the facts before mentioned. We apprehend that the cause is to be sought for in some subtile differences of minute structure, which may be spoken of as forming the quality of organization, similar to those which we have before referred to when speaking of the relation of quality and property to form, *(vid.* pp. 59, 60, *ante.)*

Phrenologists consider that one part of the brain may be in a state of activity greater than that of other parts, and have declared that a difference of temperature is perceptible in the region of the part thus active; this, they say, arises from increased flow of blood in that particular spot, thus stimulating that part of the structure to increased action and power. They say, "May not increased flow of blood, which *is* carried to the brain in thinking, produce greater density, and thus actual power may be imparted?" *(vid. Phil. of Phren.* Glasgow, 1836.) But this view is totally erroneous; we have seen that such a state could not be induced while the integrity of the structure and the normal condition of the contents of the skull remained; it is physically impossible. Of course increased flow of blood of pure character into the brain generally may occur, and does often, producing general excitement of the organ and its function; but the stimulus is then equally supplied to every part, unless the structure be in any way injured or deteriorated, when the quantity of blood would be greater or less in that portion, but this would of course be an abnormal state of things: to speak then of such an action of one part of the brain while the remainder is quiescent, is not in accordance with physiology.

But phrenologists, in an unguarded manner, admit the effect of "*temperament*," as it is called, which means nothing more than the difference between one constitution and another, and is dependent probably upon quality of organization. It is difficult enough to define temperament, and an ex-

ceedingly difficult thing to pronounce as to the kind of temperament possessed by any person. Some persons pretend to do it, but considering the accuracy requisite for the investigation of operations of the brain in connection with temperament, it appears perfectly empirical to pretend to be able to decide, with any amount of certainty, in any, much less in every case, indeed it could not be done by any physician. Phrenologists admit four kinds of temperament, "which," they say, "may be mixed ad infinitum;" in some they are however pure. Of these the *Nervous* imparts quickness of mental manifestation; the *Sanguineous*, energy; the *Bilious*, durability; and the *Lymphatic*, torpidity." How we are to detect the relative proportions in the *mixed* cases, which appear to be the most numerous, is not said. If any certain rules for defining and ascertaining precise temperament could be shown, we might then be able to say which state of organization was the most perfect and capable of complete function; but this cannot be done. To admit such an effect as that of temperament, however, is granting that which tells so decidedly against the dogma that "*size, other things being equal, is power*," because it admits the superiority of one state of organization over another, independently of size or quantity of structure, under which circumstances a small brain, deficient or inferior in quantity, must be allowed to be capable, in virtue of superior temperament or quality of organization, of performing its function in a more complete and powerful manner than one of superior size and development, but inferior in quality of organization.

Spurzheim says, "We must consider, besides the size of the organs, their *internal constitution*, their exercise, and the *mutual influence of the powers.*" And again, "Idiotism may be observed in heads of any size."—*Vide p.* 67, *Reply to Edinburgh Review.*

To recapitulate: during the proper condition of the structure of the brain, no one part or portion of it can be more active than another, that is, so far as the supply of the stimulus of the blood is concerned; and as far as the stimulus of the mind is concerned, we shall yet be able to show that such a power cannot act partially, that it has no parts or separate faculties. It has been shown also, that size or quantity of brain is not necessarily attended with power of function, because quality of organization, which phrenologists call effect of temperament, may vary. It is admitted that where we have superior quality of organization and general size combined, we should expect to find in such a case mental powers of a very high order, if cultivated.

Another point, in the operation of the brain, remains to be treated of. Phrenologists consider that one part of the brain controls and influences another, in proportion to the size of one over the other; this they call "compensation," "balancing," "subduing," "neutralizing," &c. Now such a notion is quite unphysiological, nothing of the kind is known to occur in organs of homogeneous structure; and there is no sort of ground for admitting it in the case of the brain. We do not find such an action in the liver, or stomach, or pancreas, or spleen, or muscles, or membranes, or the kidneys, during a healthy

state of the parts. Many organs exhibit more divisions and compartments than the brain; yet, even in them we are not aware of such a partial action during their healthy condition.

In conclusion, from consideration of the anatomy and minute structure of the brain, as well as the effects of injury and disease, and in comparison with the physiology of other organs, there appears no reason whatever for considering the brain as any thing else but an entire and complete organ, not divided into parts, not "a congeries of organs." Indeed, it is a mass of organic structure, every portion of which is intimately and equally connected to form the whole, and, in a manner, showing more complete and necessary union of its constituents than any other organ. Also from what has been said about mental phenomena, there appears no necessity for an organ consisting of parts, or a multiplicity of sections mapped out in the arbitrary manner of the phrenologists, since the mind is conscious of no parts and cannot act in parts. It is the entire mind which is engaged in every act, and of this all are conscious.

The accomplished author of the "Philosophical Arrangements" says:—"'Tis by virtue only of this combining, this unifying comprehension (and which, for that reason, can only belong to a being unextended and indivisible,) that the mind or intellect pronounces that A is not B, that C is unequal to D, that E is unlike to F. Were such propositions, instead of being comprehended at once by something indivisible and one, to be comprehended in portions by the different parts of something divisible; or

were they to be comprehended by a power indivisible, yet not at once, but in a succession, 'twould be as impossible either way to comprehend the real propositions, as it would, if they were to be recognized in part by a man in England, in part by one in China; or else in part by a man in the present century, in part by one of the succeeding. It may be asked in such instances, who is it that comprehends the whole?—See *Hermes*, l. iii. c. 4. Note (f.) See also *Aristot. de Animâ*, l. iii. c. 2. p. 52. *Edit. Sylb. Themist. Paraph.* p. 85. a. b."

C. *Conditions which do not influence and modify the mental function.*

By stating the converse of what has been said in the preceding divisions of our subject, a more distinct idea of the state of the case, as far as it is made out, will be formed.

1. *General size*, or quantity of the brain alone, does not necessitate nor augur the amount of mental power.

2. *Special size* of any separate part of the hemispheres does not influence mental manifestation, and is not connected with any particular or especial mental peculiarity of manifestation.

3. *The existence of the convolutions on the surface of the brain is not necessary to the mental manifestation*, either in man or lower animals; for, in some lower animals, they are not found at all; as in fish, birds, the rabbit, and marsupial animals; while in man, in cases of hydrocephalus, they are seen to have been unravelled, and the sulci quite obliterated, though the mental function has remained entire.

4. *The sulci, between the convolutions, are not necessary to the lucidity* of the ideas, or the action of the mind upon any one subject in preference to others.

5. *The abstraction of part or portions of the brain, if confined to one half, does not cause the loss of any particular faculties of the mind;* frequently no effect whatever is perceived, and the common result is that of general weakness of function; not a separation or loss of any particular manifestation of it, such as might be expected if the brain were a congeries of separate organs devoted to separate acts of the mind. Parallel results occur in cases of injury by disease.

6. *Increased supply of blood* to any part of the brain cannot influence or form part of the action of the brain, because such a state is impossible while the brain retains its healthy structure.

7. *No one part of the hemispheres acts upon another,* to regulate or influence its action; for there is no evidence that such a power of control in any one part of the brain over any other parts exists; and it is contrary to our physiology to consider that one part or portion of an organ, in a healthy condition, may be active, while another, of the same structure and properties precisely, is dormant or quiescent.

As it is designed that the mind shall act in dependance upon life and organization in this mundane condition; and as we know that *vital* operations are not regulated by size or quantity of structure but by *quality,* a small muscle being, possibly, capable of greater power than a large one; therefore the vital

and the mental forces being alike dependant, as far as regards perfection, on *quality* of structure in the fullest sense, we are to look to this rather than to "*quantity*," as the measure of mental power.

It remains to be stated that, as this "*quality*" consists in something at present beyond our knowledge and senses, it cannot be measured or appreciated; so that it is highly absurd and impossible to pronounce as to the mental capabilities of the cerebral organization by its gross quantity or its particular form.

D. *Sketch of the doctrines of phrenology, syn. cranioscopy, craniology.*

It is not at all our intention to give a history of this "new science," as it is called, or to detail all its doctrines; but as the observations and theories set forth by the advocates of this doctrine bear so distinctly upon our subject, and indeed are founded in a manner upon the same facts, and as they have excited so much attention, we are bound to notice them, and to discuss them with a fair and unprejudiced aim at the truth.

Our limits will not allow of any very complete statement of the phrenological doctrines; we shall be contented with a rapid sketch of them and their origin, as well as the position they claim as a part of true science at the present day.

The study of the expression of the features and the form of the head was pursued by the cultivated Greeks. They did not, however, teach the differences to be observed between faces so much as the differences and changes occurring in the same face, the transient condition of the features; their beautiful

sculptures of heads are mere idealised copies, and cannot be looked upon as the working out of any ideas of the influence of form over mind. They were no phrenologists, although they so well knew the beauty expressed in the lofty expanded forehead of the Jupiter, or the strength and endurance of the diminutive and receding head of the Gladiator.

In the year 1575, M. Lud. Dolce wrote a work, published at Venice, called "Dialogo nel quale si ragione del modo di accrescere e conservar la Memoria," in which he points out the situation of faculties of the mind, and in his book he shows a head mapped out somewhat after the present approved method. Speaking of the organ of memory, he says, "Il cui organo è nell' ultimo parte del capo;" and, referring to his map, "In questa tu vedi, oue e il senso commune, oue la fantasia, la cogitativa, la imaginativa, la stimativa, la memorativa, anco l'odorato e il gusto." This book may be seen in the library of the British Museum.

We must not omit to mention also the observations of the intelligent Camper, who thought that the mental powers and general character could be ascertained somewhat by means of certain imaginary lines, the chief of which he named the "facial line." According to the practice of this observer, a line was to be drawn perpendicularly through the meatus auditorius, at right angles to which another line is to be drawn, and then a line on the plane of the forehead. According as the angle formed by these lines was greater or less, so was the mental power of the subject estimated. His attention seems to have been much directed to the expression of form and

attitude in general; his book is illustrated by many admirable drawings by his own hand, not only of man but animals.

Cuvier invented a somewhat analogous method of estimating the anterior size of the brain, by viewing the head vertically; if the forehead were very receding, much more of the features would be seen than if it were full and prominent; this rule has been called the "norma verticalis;" Blumenbach's work also, on the varieties of skulls, is particularly worthy of study, though these writers both studied rather as ethnologists and naturalists than as psychologists. Perhaps also Lavater, and the other writers on physiognomy, may be said to have paved the way somewhat for phrenology, by characterizing certain heads, or countenances, as religious or weak-minded, firm, courageous, and so on. Lavater says of the eyes, "being situated near the supposed seat of the soul, every sensation of that invisible spirit appears to rush in full vigour from those intelligent organs." Camper's "facial line," in a majority of cases, might perhaps be sufficient to augur intellectuality, as the large size of the hemispheres is generally allowed to be accompanied by superior intellect.

There is no record of any further progress of such observations until the time of Gall and Spurzheim, who may be called the founders of the doctrines of phrenology; these anatomists claim to have performed the dissection of the brain in a more complete manner than any of their predecessors, and even to have instructed Reil himself. Since their time the anatomy and microscopic structure have

been minutely and carefully studied by many anatomists, who need not be mentioned; but Gall and Spurzheim's work is looked upon as one of the best on the subject; the result of their labours was directed to prove that the brain is a compound organ, consisting of a " congeries of organs," each of which might be compared to a cone, having its apex towards the centre of the brain, or to speak more correctly, towards the centre of the medulla oblongata, and its base at the surface of the convolutions; the power of each cone or organ to be estimated by the length of its component fibres from apex to base, their number, and the general size and extent of the base of the cone; the different ganglionic portions of the brain, such as the thalami, corpora striata, corpora albicantia, &c. were looked upon as proofs of the division of the substance of the brain into organs.

These views Gall supported by practical observation of the skull during life, and by comparing the form of the skull with any particular mental manifestation that the subject possessed. Following this plan, he at length formed his system of organs, and the mental functions performed by them, and laid down the rule that special external form of the brain is always attended with special mental manifestation, *other things being equal.* Spurzheim says, " the mind cannot manifest any power without the instrumentality of the brain; and each sort of manifestation depends on a particular part of the brain."

Both Gall and Spurzheim extended their observations, and thereby confirmed their views, till at

length they published a work conjointly, in which many cases are related, and sketches of heads shown, which they considered to confirm the theory advanced.

Now such a step from the dark and mysterious ranks of the followers of Locke, Reid, Brown, Stewart, &c. was very startling; the doctrine appeared highly plausible and natural; it suited the ideas of the people, amongst whom it originated, and was soon taken up by many who thought it easy to understand, and interesting to study, as well as by all who desired to rob the mind of all its mysteries, and reduce its operations to a perfect analogy with all material phenomena; both on the continent and in this kingdom the new science gained numerous followers and believers; it delighted many to be able to explain to an astonished audience all the mysteries of mind, and to show the reason why one person should be more clever than another; as Gall says, to tell "the dimensions at which men obtain the height of intelligence;" to tell people even more than they knew and believed of themselves, the rationale and cause of their thoughts and actions. Many worthy people who had never before been accused of deep thinking, now found themselves becoming mental philosophers, and professors of the true philosophy; the gentler sex was not excluded from these honourable ranks, and the boudoir was incomplete without a shorn bust of Bacon, or some other model conformation, on which were clearly mapped the various organs and the names of the mental faculties they represented; it is amusing also to see how the quack doctors and their confreres in

science continue to cling to these busts as a sort of fe-fi-fo-fum of their wisdom.

The *science* continued to advance, when the great organ of the north, Mr. G. Combe sent forth his ponderous volume of Elements, in which the subject is handled in a most masterly and confident manner, leaving no room to doubt either the accuracy of that gentleman's powers of observation, the profoundness of his reasoning, or the grand truths of the new and true philosophy of the mind.

This great work would open a new field to the statesman, the philanthropist, the religionist, and the educationist; the anxious father may now know the precise disposition and mental capabilities of his son, he may place him at once in the road to success; the careful housewife chooses a good and honest servant by the bumps she exhibits; the philanthropist can no longer lament the evil nature of man's heart, for the wretched criminal is the victim of organization; and the religious may be comforted with the idea, that a crime committed under the stimulus of an organ is not more a crime than the act of a madman; as to moral responsibility or sense of right and wrong, evil and good, there can be none without the organs of "veneration," "conscientiousness," and "benevolence;" and with the possession of these all must be right: the statesman must be guided in his ideas of justice by a proper respect to organs in the brains of the multitude; while to every man it must be a great source of satisfaction to know that one good propensity, with an organ, may act as a guard and ruler over all his bad ones; and his conscience may be quieted with the reflection, that his

faults are the effects of his conformation of brain. All these things are highly desirable and pleasing, but how far the correctness of such views can be shown, we have yet to consider.

The term "phrenology" has crept into use, and, like many other words, acquired a meaning which, strictly speaking, it cannot be said to possess; it really means the science which treats of mind alone, or what is called "psychology;" now our new philosophy treats particularly of the *brain* and of its parts, and certainly lessens the necessity for any term having reference to purely *mental operations.* If we consider the mode of origin of this new science, and the method of investigation used by those who profess it, we find that the existence of special physical form is the fact from which is deduced the existence of special metaphysical function, the aim and object of the study being to detect and conjecture the existence of a special faculty of the mind in any particular case, by observing the external form of the organ of the mind; seeing this, it appears more correct to use the term which has been proposed by physiologists; viz., "*cranioscopy*" or "*craniology,*" the former perhaps is the better one; but it is idle to carp at names so long as we understand what is meant by them, therefore we at once proceed to the doctrines of this phrenology.

Division of the brain into organs, each one being the medium by which a certain manifestation of the mind is exhibited and enabled to act so as to produce thought, is the foundation of the vital axiom of the phrenologists.

But from what we have already stated concerning

the anatomy and structure of the brain, no such divisions can be proved to exist; it cannot be demonstrated that this fundamental principle of craniology has any foundation in nature; nay, the reverse is seen to be the case, as will be remembered. Moreover we saw that injuries may be done to parts of the brain in which the phrenologists locate faculties, without the loss of these faculties by the patient; "large abscesses of the brain frequently occur without either mental or bodily disturbance" (*Otto*); while the converse was stated also, that a faculty, *e. g.*, "*memory*," is often lost, that portion of the brain allotted by the science to the faculty of memory, not being in any way injured, much less destroyed.

But it will be said by phrenologists that there are the ganglionic bodies of the brain, the thalami and corpora striata, albicantia, &c., and the commissures, the corpus callosum, and the fornix, &c.,—are these not separate organs?—they are to a certain extent separated from other parts of the brain, but rather in an arbitrary manner, for the sake of enabling anatomists to refer to certain parts of the brain; the true state of these parts we described in our sketch of the anatomy of the brain: there is no sort of proof that they are the seat of any special intellectual operations; and it remains to be said that if they were important intellectual organs, it is as if they were not to the phrenological observer, for they cannot be appreciated, inasmuch as not one of them is situated within three inches from the inner table of the skull; then, it may be asked, do not the convolutions exhibit divisions? but we must demolish this refuge also, for we have seen that they may, by proper

manipulation, be blown out and unravelled, without any destruction of the tissue, the condition often occurring as the effect of disease,—but yet, the mental faculty is not destroyed, and sometimes not injured. Spurzheim himself mentions a case of watery brain at Musselburg, which measured 39 inches in circumference, in which the mental powers were not suppressed. In some lower animals also, that are remarkable for intelligence, the convolutions are not seen at all, as in the rabbit; in others they are indistinct. In man, possessing the most perfect mental endowments, the convolutions are not symmetrical on each hemisphere; there is a general resemblance between those of each side, but not more than between one tree and another; on the contrary, in the *cat* and *dog* one side corresponds almost precisely with the other; these facts tend against the views of the phrenologists, because, if the convolutions were important organs of mind, we should expect to find them less symmetrically developed in the lower animals than in man. Then, again, numbers of these convolutions cannot be appreciated by the observer, even granting them to be organs, and sometimes they are much more numerous than common. Probably not more than two-thirds can be appreciated in the manner prescribed by phrenologists; all those convolutions situated at the base of the brain cannot possibly be measured by external manipulation; so with those between the hemispheres and above the corpus callosum, and those in the fissure of silvius. With regard to these parts phrenologists say that their size would be shown by the expansion of those parts which are in contact

with the dome of the skull, in order to make room for parts at the base or in the fissures; but unless this was accomplished during utero-gestation, we do not see how it could occur afterwards without being accompanied with serious disturbance of function. With regard to the use of these convolutions, something much more satisfactory may be stated, as we have already hinted. It is generally admitted that the grey matter at the surface of the brain is highly important for the due performance of the mental function; this being the case, it is desirable to have as much of this cortical substance in as small a compass as possible, which is attained by the doubling in of the surface. In hydrocephalus the opposite effect is seen in the unravelling of the convolutions; the inconvenient size of the head and greater liability to injury from accident, pointing out the real necessity for this convoluted arrangement. To make a rough guess we might say that by means of this indenting of the surface of the brain at least five times more surface is obtained in the same space than if there were no convolutions; the surface in contact with the dura mater is to that in the sulcus as about 1 to 5, allowing the depth of the sulcus to be about $1\frac{1}{2}$ inch. By this means also the surface is more protected, the chances of injury of course being as 1 to 5; comparison of hydrocephalic and natural heads exhibits a great expansion of surface; it has, however, rarely occurred that the convolutions remained entire in such brains, the water being contained in the ventricles.

If there were any method of estimating the amount of grey matter at the surface of the brain, we might

perhaps hope to arrive at some criterion as to the capabilities for mental manifestation; but not only will it be seen that a large portion of this important grey matter, forming the sides and bottom of the sulci, is beyond the reach of investigation during life, but that its thickness is found to vary considerably in different parts of the brain; therefore we require a method of ascertaining the precise quantity of this grey matter before any estimate of mental power or characteristics of the individual examined could be arrived at.

In conclusion, with reference to the functions of parts, it may be said, that in the cord especially, as well as in the brain, there are distinct parts which are especially connected with sensation and motor power, and that this is a proof of distinct function or faculty with an allotted portion of organism. But what are the phenomena of these faculties? do we not find that in *sensation* there is a transfer of force from without inwards, and in *motion* the reverse? hence these have been called centrifugal and centripetal actions; and sensation in a nerve is referred to its extremities, and not to its origin; we can therefore understand why some differences between the arrangement of particles and consequent division of parts of the structure should exist, by which transmission is accomplished in the one direction or the other; but as regards the *mental* operations, there being no necessity for that force to traverse; for the brain may be said to possess by means of the nerves, channels of communication in every direction; and as no divisions of its substance, corresponding to the faculties of the mind, are to be seen; knowing also

that *partial* injuries to the organ are attended with *general* loss of functions, it does appear that the mind must be considered as resident in the brain as a "sensorium commune," to receive, as it were, intelligence by means of the senses. We do not find that the mind is influenced by the loss of a limb; it remains entire though the body be mutilated, which, we submit, proves that the mind acts in the brain without traversing the nerves; if such a traversing of the mind did occur, the loss of a limb must be attended with loss of mental power.

It must be admitted that there is no necessity for all the organs and subdivisions which it delights the phrenologists to make out, for we have already shown that the mind is a unity, and acts without parts; but to this we shall yet recur more fully.

As to the subdivision and classification of faculties by phrenologists.

It has perhaps occurred to some when reading the works of writers upon mental philosophy, that the number of distinct faculties of the mind was uselessly kept up, and that some acts of the mind are treated of as elementary actions, which may be referred to more general conditions. Now phrenologists, so far from endeavouring to benefit the study of the mind by simplifying it, seem to have pursued the very reverse of that path of investigation which has led to the most brilliant discoveries; their aim has been to amplify, instead of to simplify, to make more subdivisions rather than to reduce all to general principles. The number of organs and faculties has been gradually increased since the time of Gall, while certainly nothing like sound classification of mental

phenomena has been arrived at; indeed this was not the object sought, but rather has it been attempted to build a system and frame an hypothesis, explaining the phenomena and rendering them easy of comprehension, by showing the divisions and subdivisions of an organ. The eminent German physiologist, Müller, has pronounced the psychological arrangement of the phrenologists to be faulty, of which he says, "We may at once exclude from the forum of scientific researches, these arbitrary dogmas which can never be proved"—"the system of organs has no foundation." We will allude to some examples in which it may be discovered to be so: the phrenological arrangement distinguishes a faculty for "*number*" and one for "*time;*" now these ideas are set up in the mind only by the comparison of one idea with another and the consequent formation of abstract notions, which is a process of reasoning; but then phrenologists have a distinct faculty of "causality," and one of "comparison," and some of "perception," to which the work of reasoning is allotted. Now we cannot deny that the faculty of comparison or causality, granting such to exist, which we do not, should suffice to comprehend all ideas about number and time; yet two distinct organs are discovered by phrenologists by which the ideas of number or time are excited or controlled. Again, some states of the mind cannot be composed by means of the phrenological series of faculties,—such as "hatred," "revenge," and "religious feeling;" as to "*emotions*," they are always regulated by the *relation* of the object which excites them to ourselves, which cannot be

explained if the same amount of organism is in action always in the same person. Many other instances might be mentioned, as the effect of "*conversion*" in religion and intense *reflective action* of the mind; but these remarks will suffice to point out the incompleteness of the theory as far as regards psychological arrangement.

As to the localizing of faculties.—The general fact of the brain being the organ of the mind is admitted by all; and we may perhaps venture to say, that the hemispheres are the especial organs of the intellect. Yet if we attempt to go beyond this, we verge upon hypothesis: however, phrenologists boldly tell us, that the anterior portions of the hemispheres are the seat of intellect, and the superior of the "sentiments," which, by the way, is a rather obscure word, while the posterior are devoted to the propensities or animal faculties. We will forego the discussion of the psychology of such an arrangement, to point out that this would be anatomically wrong, for the posterior or animal regions are deficient in some lower animals; a sheep, *e. g.*, possesses no posterior lobes of its brain, only the middle and anterior, therefore it should be only intellectual and sentimental; a sufficient absurdity. The posterior part of the brain in man is commonly larger than the anterior; and in comparison with the same parts of the brain in lower animals, is much larger in proportion than the same part in any of them; but we do not find that man at all equals the lower animals in the care and "*love of offspring*" or "*inhabitiveness,*" the love of particular places, all of which faculties are located by phrenologists in the posterior

parts of the brain: again, in children the most prominent parts of the brain are those to which the faculties of "*reasoning*" and "*caution*" are allotted, which is rather paradoxical; the proper explanation of the fact being, that those parts of the brain appear exceedingly prominent on account of the large proportionate size of the brain and the smallness of the face, the greatest length and breadth of the brain being at those points.

After all, supposing that the theory of phrenology were correct, that the brain was divided in the way they propose, the case then stands thus:—

1. *Many parts of the brain cannot be examined.*

2. *Those which are in contact with the skull do not impress their form upon the outer surface of the skull.* This has been repeatedly observed in making sections of the skull and brain horizontally; the inner table of the skull, which is of delicate texture, does correspond greatly to the form of the brain; but this differs widely from the form shown on the surface of the external table, especially in some parts of the skull, *e. g.*, at the frontal sinus; then there is the diploe, a sort of network of bone, between the tables we have spoken of, which prevents the outer table from taking the form of the inner one. Sometimes the frontal or ethmoidal cells enlarge towards the brain, while the external surface of the skull is unaltered.

3. *The effect of education which is admitted by phrenologists cannot be measured or felt.*

4. *The effect of temperament, also admitted to be of great importance, cannot be measured or felt.*

5. *The two last propositions being allowed, no*

judgment can be formed with any degree of certainty as to any brain.—Any one who would pretend to pronounce with any certainty, must possess the feigned art of the astrologers, and, to our mind, would deserve as much credit as Virgil's Stygian Sybil or Johanna Southcote.

In concluding our sketch of phrenology, we need not be surprised that, although it has been shown to be so full of absurdities, and so contrary to fact and observation, that the number of its followers and teachers has continued to increase. It is not the first dogma of a similar kind that has lived before the world, and in enlightened times too.

Astrology has held its sway up to the present day, alchemy, witchcraft, fortune-telling, miracle-working, and, now again, mesmerism, which has taken phrenology into partnership under the firm of "prenomesmerism," have their numerous believers and professors. As to the subject before us, the doctrine originated without support by facts of anatomy, and regardless of the effects of disease and experiment upon the brain, indeed it proceeded in a manner contrary and in opposition to all such facts.

Without predicting the downfall of this interesting science we must nevertheless be allowed to say that some of the highest authorities in physiology and anatomy, as well as in psychology, are opposed to it; and the latest work in physiology, in which the subject is very fully considered, tends decidedly against the doctrines. "There are no facts calculated in the slightest measure to prove the correctness of the hypothesis generally, or the correctness of the details of the doctrine founded upon it. No part of the

brain can be distinctly pointed out as the seat of memory, of imagination, &c. Memory may be lost as a consequence of lesion of the hemispheres at any part of their periphery; and the same is the case with regard to all the principal faculties or tendencies of the mind." *(Müller.)* But our endeavour is not to bring together all the facts and arguments possible in refutation of the doctrines of craniology, rather is it the particular aim of these essays to apply our latest knowledge in anatomy, physiology, medicine, and psychology, to the subject of "mind" as connected with matter, and to show how far certain phenomena we can observe can be satisfactorily accounted for or not.

E. *Degrees of mental power.*—That all mankind are not equally endowed with mental power; that there are wide differences in this respect between the races of men, between men of the same race and nation, and even between men of the same family, born of the same parents, are facts which need no illustration; for we are all well aware of them.

We cannot allow that there is any difference between one mind and another, speaking of a mind as unconnected with the body: this point we discussed when treating of the dependance of mental manifestation on organisation.

Now the phrenologists, seeing this, endeavour to account for the differences between the mental powers of men, by showing the existence of corresponding differences, which they say are to be observed in the external forms of the brain.

As to the general theory attempted to be made out, enough has been said; and if we have withheld from

it all support from anatomy, physiology, and medicine, we may still be asked, how can the differences in the mental properties of men be accounted for? To explain these there is no reason for stating that one man possesses parts of the brain which another does not: the differences of form between the brains of men are but insignificant and not sufficient to account for the remarkable differences in their mental powers. In comparing carefully the brains of one race of men with those of other races, certain differences, as we have before remarked, are to be seen; the general size or quantity of brain, more especially of the hemispheres, may be less in the bushman, the negro and other tribes of Africans, than it is in the European; and perhaps it may be said that the anterior portions are more deficient than the posterior; but this is of somewhat doubtful signification, especially as regards those cases which are often cited as deficiencies, viz., the Carib and the Indian of the rocky mountains; for in these we know that strong mechanical force is used to give the head that peculiar receding shape. The observations we have before quoted relative to increase and diminution of the weight of brains at different ages do not refer to size; the increase in size from sixteen years to thirty-five, if any, must be infinitely out of proportion to the increase in mental qualifications; the decrease in weight which accompanies the advance of old age is out of proportion to the decrease in size, and the diminution in respect of both is greater than the failure of the mental faculties would lead us to expect; because we often see a man in the full vigour of intellect at sixty, although according to the obser-

vations referred to, which must be relied upon, he has lost 2oz. of brain. A series of observations to show the bulk of brain in comparison with its weight in different cases, so as to arrive at its density, would be an interesting source of information on this subject; for the state of the minute structure appears to be connected chiefly with the perfection of the mental function.

With regard to particular parts of the encephalon which are distinguished by anatomists; there is very little difference to be found between them in one brain and another, not more than it is usual to find as varieties in any other organs of the body; though we must not forget the case mentioned by Cruveilhier of a man forty-two years of age in which one hemisphere was only half the size of the other in all its parts; but nevertheless the mind was perfect. (vid. Livraison viii.)

We may conclude that though there may be large or small brains, the differences in size or weight are not sufficient to account for the varying power of mental function occurring previous to senility; and especially that brains are devoid of such differences as could be said to verify the doctrines of phrenology.

As regards "anterior development."—Phrenologists pay great attention to the amount of brain observed between the forehead and the ear. First of all it may be asked do we find that the anterior portion of the hemispheres so far preponderates over that of the posterior as to be remarkable? It cannot be admitted that it does; as far as my own observation of heads and of brains viewed in the skull

goes, the posterior portion appears to be generally larger than the anterior in every way.

In comparing the brains of intellectual people with those of persons of mediocre talents, we do not find a sufficient difference between them to enable us to account for their superior intellectuality; nay, in many instances it has been found that their brains are smaller as regards general bulk, and not particularly large as regards the anterior part; on the contrary, in idiots the common form of the head is conical, which admits of general deficiency and abnormal development of the hemispheres of the brain both *anteriorly* and *posteriorly;* and it must not be forgotten that they often possess very large and well-formed heads: the reverse of the conical form, equivalent to the square-shaped or well-formed head, would doubtless be attended with superior mental power, provided the *conditions of organization* were perfect; but this fact is nothing new, it is not a fact of phrenology, it has been admitted for ages; it is perfectly correct, and in accordance with what we observe in other organs; the condition of the organ being perfectly sound and normal in every respect, we find that increase in quantity of the organ may be attended with a superior display of function; but not necessarily so, because size can be no measure of the intensity of the function or the dynamicality of an organ, since it is no measure of the quality and perfectness of organization: a small arm may be stronger than a large one, and a moderate-sized liver may perform the function as well as a very large one. But the existence of such differences is undeniable, and the cause of them must exist; is

there not some more rational and consistent explanation?

In speaking of the conditions requisite for vital operations, and the action of vital phenomena, we saw that "*structure*" is absolutely necessary, and that in order to exhibit the higher vital operations such as sensation and power of moving, a still more complete and complex form of structure is necessary: to render our meaning plain let us take an example from a class of vitalized objects below the animals; a seed retains the structure and constitution necessary to its life in a remarkable manner, entirely by virtue of the peculiar arrangement of its particles and general organised condition, for if these have been destroyed by heat, or putridity, or mechanical violence, the life is lost; exposed to the proper conditions for growth the seed undergoes various changes, from the first simple shoot to the tender plant which continues, by virtue of mysterious operations going on within it, to grow and increase, changing gradually to a tree it performs a still higher part; it blossoms, the flowers may give *fruit or not*, according as the vital conditions are fulfilled; this fruit will be of the proper and peculiar character; so that although trees themselves and their blossoms may be exceedingly alike as to external form and internal structure, still they must differ in the properties of their organism, though in what this difference consists is another question.

Now a precisely similar process may be traced in animals; we have already stated that the *germs* of all animals are scarcely to be distinguished from one another, so much are they alike; but each is en-

dowed with that peculiar and mysterious property which determines what special form shall be produced from it; though they are all susceptible of the same influences, and submitted to the same general agents, yet there is no confusion because of the peculiar and proper qualification resident in each, which property or quality, subtile and inappreciable as it is, may be deranged or lost altogether, as indeed is often the case.

Thus a very different property or quality may reside in two structures apparently the same, and absolutely the same as to form and quantity.

We do not find that the vital force, which we have compared with the mental so often, is at all affected by the form or quantity of the structure it animates; a man may lose every limb and yet retain his life, and his vital functions will be performed with equal vigour. The organs of the body are often variously deformed without injury to life, at least in any remarkable degree; vitality is thus shown to pervade every part of the body, but the loss of many parts does not diminish the perfection of the vitality nor its complete action in all that remains; this is another proof that any special quantity or form is not necessary to such functions, but only a peculiar and proper state of organism in the structure of the parts; hence we say, that the most perfect function may be performed by a small organ, and the completeness of that function does not depend upon perfection of form or quantity, but upon the perfection of the minute structure and of the subtile organical operations going on in it.

Now there appears no reason whatever why the

brain should not be studied by the same rules as are applied to other organs; the beautiful structure which we have described as forming it, and which can be seen and demonstrated, is no doubt necessary to the performance of the function of the mind; but we have not been able to show any thing like the phrenological subdivision of this structure, or any great differences in form or quantity of the organ, either in general, as regards the brains of different individuals, or in particular, as regards parts of the brain in any special case. There are other reasons also, derived from observation of effects of injury and disease, which we have before stated, for considering the perfection of *structure* as highly important.

Although we have seen that many alterations of structure are to be detected as the result of disease, yet many cases occur in which the function has been deranged yet no difference in the minute structure can be detected, even by the most accurate research; the microscopic examination of the structure of the brain of an idiot shall show it to be as perfect as that of a Bacon, but we cannot allow that the organic conditions of the two have been similar and equal; we can observe no difference between the filaments and their structure, in a nerve of sensation and one of motion, yet doubtless there is a difference as yet too subtile for our powers of observation.

We apprehend that, for the explanation of those differences between man and man to which we have referred, we are to look to minute structure, and to the perfection of the organical operations of structure, if not to still more abstruse influences, rather than to

differences in form and quantity, which are the basis of a more gross and clumsy doctrine.

It may be said we are ascribing effects to a condition which we cannot observe or appreciate, but we have proved that they cannot be attributed to "quantity," or to "form," or to "subdivision," therefore we suggest the next probable cause of them; and as to its being an operation not appreciable by our senses, there is nothing new in attributing effects to such a condition as this; no one has yet seen the electric, or the magnetic force, or heat, or sound, or light, but the properties and phenomena of all these are known and studied with accuracy.

Having then established the importance of what we call quality of organization, let us proceed to speak *of some modifications of organism in general, and of that of the brain in particular.*

Exercise of all organs tends to improve their power of performing the allotted function; this is well known to all: a man who never exercises his muscles can never become a strong man, and a man who does may become a stronger man than he who does not, although the latter may be apparently the stronger; so with the other organs that are endowed with the more delicate functions, such as the eye, ear, and skin, &c., all the senses of which they are the organs may be much improved by practice. It requires great practice to become a good microscopical observer, and the blind man has a much finer sense of touch than he who sees what he feels, because he is compelled to substitute touch for sight.

As to the effects of exercise upon the structure; in muscles there is a manifest difference, as the result

of exercise; they become of a larger *size* frequently, though not always, their *colour* becomes somewhat deeper and their *shape* more decided; and as age comes on they become denser and tougher; these changes are observable to the eye; there may have been others which are not evident; the conditions of muscles in a paralyzed limb, or in cases of more direct impediment, as from keeping a limb tied up, are positive examples of alteration of structure from want of proper exercise and complete organic control; in such cases the muscles are frequently seen reduced to little more than a mass of dense cellular tissue: in the eye if the apparatus of vision is destroyed, the optic nerve gradually decreases in size and becomes altered in structure, eventually becoming very different indeed from a nerve, in fact, nothing more than condensed cellular tissue.

With regard to the effect of exercise upon the body generally, we all know its importance in promoting the healthy action of our complicated bodies; we cannot *see* any effects that exercise produces; we may observe or be conscious of effects, but they are secondary; the primary conditions set up are probably of a nature beyond our present powers of investigation, the fact, however, is not disputed.

There is, then, such a thing as perfectibility of organic conditions, though in what it consists we are unable to conjecture; various alterations of this condition are seen in cases of simple derangement of structure, in which no difference in the organ is perceptible, as when a person has not the power of discriminating between colours, or has no taste or smell, or is deaf; even the sense of touch may be altered in

various ways in a topical manner; and, above all, we have seen that complete pervertion of the mental functions, amounting to absolute madness, may occur, and indeed does frequently, without any appreciable difference in the structure or appearance of the brain.

Perhaps no organ is more susceptible of these organical influences and sympathies than the brain; the slightest increase or decrease in the circulation of blood produces effects in the brain; alteration in the respiration also is connected with effects upon the brain; derangements of the stomach and liver are especially productive of pain and uncomfortable feelings in the head, nay, the mind is very often seriously affected from this source; the sense of hunger and appetite for food is not resident in the stomach, but is intimately connected with the brain; for animals are hungry and eat when the stomach has been removed; drunkenness becomes at last a species of insanity, from the great sympathy between these parts. *Cold* produces great effect upon the brain and nervous system; it is almost impossible to study if the body is very cold; and the intense drowsiness produced by extreme cold is also a remarkable instance; *heat* has a similar influence, but not to the same extent; *climate* also produces curious, but evident effects, persons inhabiting northern climes of low temperature, &c., are not possessed of that vivacity of mind and body that distinguishes those of the south and east (*Quetelet*). We can offer no satisfactory explanation of these phenomena.

Electricity excites a manifest influence over the brain and nervous system; many persons can foretel

storms by the sense of pain they feel in the head, and some are unable to remain in the same room with an electrical machine in operation. The condition of *pain* in the head greatly prevents the due performance of the function of the brain; we cannot think accurately while we suffer in this way.

Lastly, it remains to be said, that no organ benefits more by exercise than the brain, *i. e.*, when properly exercised; the effects of education, culture, and practice in the use of our understanding are very striking; every one must have observed in his own case the great increase in the facility of his mental application caused by study or even simple repetition of the same process of the mind, such as that required for reading and playing music, or rapid arithmetical calculation. The improvement of the memory by constantly taxing it and increasing its efforts, is perhaps an instance of more genuine exercise; and as regards the higher kinds of study, such as logic, psychology, the mathematics, &c., considerable training is requisite before the mind is enabled to embrace such thoughts as are requisite in those studies. The increase in power, as the effect of exercise, is very great—immeasurably great: if every man's head increased in proportion as his mental powers were strengthened, it would very soon be too large for his body; but we cannot possibly pretend to say that the size of the brain, as a whole or in parts, keeps pace with the increase of the mental powers; such a state has never been observed. The general size of the hemispheres in an individual, if joined with that perfection of organic condition that we have spoken of, may be an index of the powers of

the mind belonging to that brain; but we have shown that it is next to impossible to judge as to the existence or not of such perfectibility of organization, therefore our knowledge is of little avail in prediction of the character or powers of mind. We have before seen what very great stress Spurzheim and Gall lay upon the internal constitution of their organs.

The differences between the mental powers of men of the same nation, and even of one family, are often very great—quite as great as those between an intellectual European and an ordinary uneducated negro, yet the difference between the brains of the two Europeans is not so great as in the case of the negro, as compared with the European, which ought to be the case, if phrenology were correct.

But we have allowed that a difference exists in the general bulk of the hemispheres in the negro and European; can we account for this? Lack of exercise in the body is followed by loss of power and, subsequently, diminution and alteration of the structure of the organ. Now if we imagine a nation arising and progressing in an inaccessible country, shut out from all civilization, and under the influence of a peculiar and enervating climate, tending to encourage indolence and the gross passions, and remaining in this state for ages, we should not expect to find the organ of the mind in a high and vigorous condition amongst such a people: such has been the condition of the negro race; and as hereditary peculiarities of many kinds are known to be entailed upon the offspring, their mental condition, and with it the organic condition of their

brain has sunk, partly from the deterioration caused by want of exercise and stress upon the organ, partly from hereditary disposition to inferiority of development; however, since these races have had the opportunities and the stimulus for acquiring knowledge, their mental powers have universally and wonderfully improved, some having become highly educated, and in a manner perfectly equal to Europeans, yet their peculiar conformation of brain has remained much the same, and probably will, until a time equal to that which had been spent without cultivation shall have been passed under a system of culture and education, when in all probability the general size of the brain and its quality of organization will be found equal to those of Europeans. In addition to the case of the educated African, we meet every day with celebrated and highly educated men, whose heads give but a very inadequate expression of their mental and moral powers.

In concluding this branch of our subject, it must occur to the reader, that it is much more satisfactory to know that we may attain any pitch of excellence by study; and that as we proceed, the means of mental manifestation (so far as organism of the brain is concerned,) are improved and rendered more available, than to think that if any man has not the good fortune to have certain bumps, he never can advance in attainments, that all the study in the world would be useless if he has not the organs; nay, how much more philosophical and physiologically correct is that view which we have been endeavouring to point out: it is true we have admitted a great difficulty as regards the condition which we

have named, "quality of organization," yet, nevertheless, all we have said is in accordance with facts. We submit whether this is not better than to explain every thing by means of an hypothesis, and that hypothesis one so exceedingly opposed to facts of anatomy, physiology, medicine, and psychology as phrenology is.

F. Theory of mental organic action. In speaking of a "theory," of the mental phenomena, it must not be supposed that we are able, or profess, to explain the mystery of mind and its action upon matter, but since we have shown that the doctrines of phrenology, the latest and most popular psychical theory, cannot be proved correct, nay, that they can be proved incorrect, it behoves us to make some attempt to offer a theory or explanation, if any can be offered. There are *several points of analogy between mental operations and those of the senses:* some authors have distinguished the senses into those which are accompanied with a direct sense of the impression and contact of any object in conjunction with any ideas that may arise as the result of that impression, such as "touch," "taste," "smell;" and those in which as far as we can feel, we have no sense of the impression but only *perception* of the sensation or *idea* caused by the object, as in "seeing" and "hearing;" the two latter have hence been called "refined sensations:" now though this division may not be strictly correct, yet it is convenient to our present purpose to take such a view.

The conditions necessary for the phenomena of sensation are, 1, An organized structure of a peculiar kind adapted to receive impressions; 2, the

impression of a foreign substance. These are the conditions for what may be called the first act of sensation; but the phenomenon is not complete without the perception of that sensation, therefore we have a 3rd *condition*, which is the connection of the peripheral portion of the nervous system with the brain or central part which must be in a normal state. The points to be kept in mind are, *the organised* and *sensitive structure*, and *the impression*. So much for a general description of the conditions of sensation.

Now in the senses of touch, taste and smell, we can for the most part feel and see the object producing the sensation, but in seeing and hearing, we are not conscious of any impression of matter, we take notice only of the perception of an impression, which does certainly appear to be set up in a more refined manner; yet it is a question whether something like an impression may not be felt in seeing and hearing, indeed we find, that if either operation be performed very often, the sensitive surface suffers; *e. g.*, if the ear is made to listen to perfectly harmonious sounds, played loud and for a very long time, the nervous structure of the ear suffers, and even inflammation with permanent injury may be produced; so with the eye, we cannot look upon any one colour for a great length of time without suffering; and it frequently happens when the eye is affected that it is not able to bear the effects of the rays of light; when this effect is the result of affection of the brain, of which it is constantly a symptom, we have a better example of the sensitiveness of the brain; and persons who have lived to a considerable

age, suffering under cataract, have described their feelings after the operation for removal, as if the objects they saw "touched their eyes;" all this reduces these refined sensations somewhat to the level of those senses in which we are evidently sensible of an impression. We cannot explain the facts above stated, it is true it has been discovered that the arrangement of the nerves in the various sentient surfaces differs; *i. e.*, that they end at those surfaces in a peculiar manner, but their minute structure is precisely the same, and their chemical composition also, at least so far as we are able to observe.

When we compare the mental phenomena with those we have just dismissed, we find, that there is a striking analogy between them, for mental phenomena may be divided into two classes: 1. Those which occur in direct reference to an object; such as all ideas of matter, form, space, time, number, qualities, and properties of bodies. 2. *Those which occur independently* of any impression from without at the time existing; such as abstract ideas, imaginative faculty, associating faculty, memory, reasoning faculty, consciousness, and the moral feelings or properties of the soul.

The general conditions necessary for mental manifestation have been mentioned, they are very similar to those required for sensation and the senses, indeed the senses might almost be included in our first class of mental phenomena. As we said of the senses, even of those which we allowed to be more refined and more analogous to the mental operations, if their operation be prolonged or exaggerated the organism belonging to them is injured and perhaps

destroyed, the manifestation of function being at the same time perverted or obscured; just so it is in the mind, prolonged or excessive performance of its allotted function is attended with loss of power or derangement of the function, combined frequently with positive injury to the organ itself.

All this proves that certain mysterious, and at present inexplicable and inappreciable operations, do occur amongst the organic molecules of a sentient structure, and without them we cannot suppose that any manifestation or even operation of sense could occur.

There is nothing impious or unnatural in urging the analogy between the senses and the mental operations, for we do not lessen the mystery at all; the one is as wonderful and inexplicable as the other; but as something like an explanation of the phenomena of sensation may be thus arrived at, it appears desirable to point out how far the mental phenomena may be capable of similar explanation.

All animals possessed of a cerebral collection are endowed with faculties of mind, and there is no reason for admitting in their case the operation of any phenomena superior or more refined than those of sensation; in man may we not consider the mental powers, however superior, to be connected with if not dependant upon a superior organized condition of his brain? Such a view does not necessarily detract from his qualities as a God-like being, or his responsibility as a created and conscientious being, for the properties of the soul are essential only to morals and religion, and these we know are found to be universally possessed by all human creatures

independently of education or example, and in an equal degree by all grades of minds, whether they deserve to be denominated highly intellectual, inferior, or wholly rude.

Although we cannot pretend to state any thing like a matured and correct account of the manner in which the brain performs its mental function, yet by way of bringing the subject more within the range of analogical observations it may be said that there is a corresponding power in the organism of the brain to that possessed by the organism of the retina and the optic nerve, which enables these parts in a mysterious manner to perceive the differences between impressions. Of course this is no explanation of the phenomenon, but no one doubts that the delicate structure of the retina is in some manner susceptible of the impressions of *light*, an element of so subtile a nature, of the actual characters or constituents of which we know nothing, which we cannot weigh, which we can no more appreciate than we can the force of "*life*" and "*mind.*" We have already shown that the brain is the organism by which the mind is manifested, and that defects in it are accompanied by defects in the mental properties of the individual; especially, too, when we consider that the mental phenomena and those of sensation, of vision, &c. are all dependant upon the nervous system, it would seem natural to conclude, that the laws which regulate the action of the one are those also which influence the other.

As the result of the residence of such a peculiar quality in these structures, sensations and ideas of objects arise; in the skin and the eye in reference to

material objects alone, but in the brain in reference to both material and purely ideal impressions, or what we have called, by way of opposition, "*simple*," and "*abstract*" ideas. "The mind seems to act upon ideas as the senses do upon impressions." (See Art. "Metaphysics," *Edinb. Encyclopædia.*)

It is highly curious and interesting to observe that this view is somewhat supported by the phenomena of optical illusions, or what are called "visions," in which cases, from some unexplained state of the nervous system, the function of vision is so performed as to render the state closely analogous to that of the imaginative mode of the mind in the brain; an impression shall exist in the retina without an object being presented; in what this condition consists we do not pretend to say, but certainly it appears very similar to the action of the "fancy," when we see as it were with "the *mind's* eye."

The reality of visions is most firmly believed by many persons, so close a resemblance do they afford to the real things of which they are the imperfect images: in most cases the person seeing them is disposed to be struck by the exactness of the semblance, which is, indeed, rendered more complete by the "filling up" of the fancy; and the general state of the mind is averse to that scrutiny required to observe the defects and real nature of the phenomenon; but we have more to do with the physical causes of visions. The images of objects of sight, which have occupied the eyes for any length of time, very commonly appear, when the eyes are closed, just as we hear in the mind, as it were, the sounds of music which we have listened to in reality; these

occur independent of the will, and are examples of the " perception of sensations in the organs of the senses, dependent on internal causes, and not excited by external objects." An exaggerated condition often occurs, generally the effect of sympathy of the nervous system with the stomach, in which the objects appear luminous, either in colours or white, and in all kinds of forms and movements; sometimes accompanied by sudden loud sounds, merging into the fancied horrors of nightmare. The case of Nicolai, the bookseller of Berlin, is a remarkable instance of the physical cause of visions; he was accustomed to be bled twice a-year; this was neglected, and after a quarrel he began to see spectres and figures walking and talking; they remained four weeks, when he was bled, and on the same day they grew paler, began to fade, and move more slowly, until they seemed to dissolve away, leaving fragments visible for some time. (*Berliner Monatschrift*, 1799, *Mai.*) It is said that Goethe, having been offended by Nicolai, caricatured him in Faust as the Proctophantasmist in the scene on the Blocksberg. (*Müller.*)

A still further state is observed in the hallucination of the insane. In fever, inflammation of the brain, and during the effect of narcotics on the system, these phantasms constantly occur; although the eye has been extirpated, and even the whole optic nerves destroyed, yet these coloured and luminous visions occur, (*Luicke and Esquirol,*) showing that the senses, although generally necessary for perception of ideas, are not always, and that the condition which a sensation excites upon the sensorium

(brain) may be set up by other causes than real sensation; thus these phenomena form the link between our first and second class of mental phenomena, and we see how much certain modes of the mind are influenced by material causes. It is worthy of remark, as tending to separate further the two classes of mental action of which we have spoken, that the higher modes of the mind, the intellectual, exist in total disregard of those connected with sensations whether real or illusive: in intense thought even bodily injury may be done without evidence of sensation.

According to this view, we say that the organic condition of the brain is fitted for the manifestation of the mind; that this condition may be modified or thrown into the state in which "ideas" exist, either by the impression of objects from without, or by the action of a force within, and that the two conditions run one into the other; then, as we have before stated, perfection of the organic condition, and completeness in the setting up of the mode of "ideas," would be the conditions necessary for superior intellectual manifestation. It will be observed that this is widely different from the doctrines of phrenology, which contend mainly for the production of mental power by the *quantity* of branular collection.

We can find no necessity for considering the mind as composed of parts, and the brain as made up of insulated portions, to be the organs of those parts or faculties of the mind; in the brain we know nothing of the kind exists, and as to the mind, it is impossible to conceive of it as having parts—indeed there is

no need for considering it as such, except to find something for Dr. Gall's organs to perform.

As regards the mutual reaction of mind and body nothing satisfactory can be said. Herbart's theory of "monads" appears to be only a sort of method for describing the phenomena, and obliges us to conceive a metaphysical "monad" like the "point" of mathematicians; he says, "every organic body is a system of monads, which are themselves the subjects of a system of internal states, arising from the reciprocal action and re-action of the monads on each other." With regard to mind and body, the re-action "consists of the action of the mental monad upon the internal states of the monads of the body." This mental monad may move without trace or even knowledge of it itself, and its seat is not limited to the brain; he thinks also that it is not certain that we have but one mind; this reminds us of Dr. Wigan's theory of a "dual mind," one for each hemisphere of the brain, which can scarcely be better supported. This view of monads seems to mean that a mental principle ("monad") influences the organic condition ("internal states") of the molecules of the brain: the existence of certain peculiar molecular qualities not perceptible but by their effects, is feasible enough, and, as we have seen, has its parallels in the physical forces; but how a mental monad, an intelligent mind, can be the result of the reciprocal action of the molecules endued with any subtile qualities, is totally inexplicable. Müller says, "it is best, therefore, to limit ourselves to the supposition that the clearness and distinctness of our ideas depend on the intensity of the organic actions

of the grey globules or nucleated corpuscles of the brain," (p. 1346, *Elements.*) Still, seeing that many of the brutes possess faculties of mind common also to man, and knowing that the phenomena of sensation which are influenced by natural effects, are analogous to those of the mind which in their turn are also influenced by material causes, there appears some hope of our being able to explain those mental actions which we have placed as of the first degree.

It sometimes happens, in insanity and other cases of disease of the brain, that persons lose their power of speaking their native language, and speak some other which they have learned, or they may lose the memory for certain words, or parts of speech, or miscall things, or use an adjective for a substantive; and occasionally, in cases of severe concussion of the brain, it is not uncommon to find at first, after recovery from the more severe effects, the power of recollecting any circumstances connected with the accident entirely gone, but that this faculty returns gradually, and the facts immediately connected with the injury are remembered, then those more remote; and at length, if the process of cure proceed, matters of business which the patient intended to do before the injury, are recollected. Such cases as these have led to the supposition that certain strata of the brain were gradually called into play, or that the corpuscules of the grey matter were acted upon in succession from one to another, or that they acted from their centre to the circumferences, or the reverse; but all these views are exceedingly problematical. With regard to memory it seems natural

that a greater degree of power or completeness of the faculty should be exercised in the recollection of events some time passed, than in that of those which have just occurred; so that we may conceive that as the organ recovers its proper condition the superior faculty returns, without the supposition of any successive change in parts of the brain. In the use of language the higher exercise of the mind is required, so that we might expect to find the abstract ideas confused, as in the miscalling of things, but why a foreign language should be used, appears inexplicable.

Though what we have hitherto said refers to the action of the brain generally, yet it must not be overlooked that *there are various kinds of mental action.* Can all these be performed by one and the same structure? In speaking of the mental phenomena we showed how much one faculty is connected with another, and that mental phenomena might be much simplified, and reduced to a few modes of action which, probably, run one into the other; according to Müller, all mental actions are due to the origin and operation of ideas.

It may be conjectured, that certain appropriate conditions of the cerebral organism exist during certain states of the mind, or under the occurrence of certain mental manifestations, and that these are modes both of "*mind*" and "*organization*" or organic action; also, that if more than one cannot exist at the same time, the transition from one to another is excessively rapid and easy, and, in a great measure, under the control of the will: in addition, it is important to consider, that during the manifes-

tation of mind the whole of the hemispheres at least must be concerned, and not any one isolated spot.

As to the connection of life and mind, and their origin in individuals.—In the consideration of this part of our subject the reader will see the necessity for understanding something of the vital phenomena and the theories of life: such is the intimate connection of "life" and "mind," that we cannot discriminate between them. (See p. 85, *ante.)* But there are cases in which life exists without any mentality, as in seeds, and shoots, and germs of animals: without entering upon the difficult subject of mind in plants, let us refer to some instances among the lowest animals. In some simple animals, *e.g.* the polygastric animalcule, chilodon uncinatus, planariæ, polypes, some kinds of worms, (nais proboscidea) a new animal is produced either by a bud or shoot, as in a plant, or by a gradual division of the parent, each half becoming a new creature. *(See Fig.* 1, 2, 3, 4, 5, *and* a, b, c, d, *Pl. II.)* In these cases the sprout and portion separating from the parent are under the control of the entire animal, which is said to be "endowed with a centre of nervous action or brain," so long as they are connected with the parent organism, but immediately on separating, they become possessed of individual powers: the question is, where does mind take its origin? Müller considers that the "primitive formative force" and the mental principle remain latent, in the same manner as he explains the state of the same forces in the germ, which he calls a "potentiality" derived from the parent; the term "latent" is not, however, satisfactory, and we are inclined to think that the newly-

separated and incomplete animal is at first actuated by external agencies, assisted by the functions of a vitality parallel to that of vegetables, and that the mental functions are not performed until certain changes have taken place in the structure; for it is ascertained that "the different tissues become transformed into germinal or formative cells, the elementary parts of the tissues of the new animal being subsequently produced by the transformation of those cells, and thus the different tissues of the embryo are developed," *(Müller)* or we would rather conclude, that there exists in the part destined to be separated in the manner described, some rudiment of a mental and nervous system to be developed, for it is found that "very small portions of a polype cut from its body or cephalic part became converted into new creatures, and soon acquired independent voluntary motion, whereas the arms, when separated from the body, manifested no reproductive power." (*Trembley.*)

In man and the mammalia it occasionally happens that the young are born without brain, or with some insignificant portions of it; in these cases the simplest mental functions, such as voluntary motion, are sometimes performed, as well as the animal; we can scarcely admit the existence of any latent intellect here, but rather that the amount of faculty displayed is directly dependent on the perfection of the organism. We have before seen how gradually the mental powers are developed in man, and how they are accompanied with important and evident changes in the brain of the child; from other arguments, too, there appears every reason why we should consider

intellect as dependent on perfection of the organism of the brain; whether the infant possesses "potentially" the thoughts of man without the means of exhibiting them, is a question not so easily handled.

It is clear that "mind" cannot exist without life, but not that "life" cannot exist without "mind," although this may be allowed as an open question: the condition of both these forces, (if they be two,) in the germ of animals, or whether they exist at all, either latent or active, in such a primitive cell, until the effect of physical agents occurs, cannot be determined; observation would lead us to say, they do not exist without certain material actions, though the explanation of these involves equal difficulties with the theory of original or parental potentiality.

In concluding these essays, our consideration of the whole subject will be rather more complete if a few general remarks are made *concerning the cessation* of "*life*," and "*mind*."

In the first part, while speaking of life and organization, we saw that living bodies are subject to constant changes, first, the germ containing the concentrated force of life begins to change, then growth and development leading on by nutrition to a period of maturity or prime; then a state of deterioration commences, various signs of age appear, weakness and other signs indicating the loss of vital power; the organized form gradually loses more and more of that force which controls it, until death occurs followed by decomposition of the elements

composing the structure, and proceeding until no particle of vitalized substance remains; and so with all living bodies.

Various theories are offered in explanation of these phenomena; by some, the germ is considered to be the opposite condition to that of the body in old age; that the vital force becomes spread out and divided amongst the different parts of the increasing organism, and the more the force is thus attenuated, as it were, the less is its control over the organism, and the less is the susceptibility of the organism to the influence of regular vital stimuli, until at last the flame of life fails from want of due supply of vitalised particles; this is an explanation, but it is not a very satisfactory one, if indeed it can be called one at all.

As to the cause of death, very little indeed can be said by physiologists.—M. Sniadecki has supposed that life is gradually being worn away or destroyed by certain inorganic influences, but if this were true, there could be no period of maturity or perfection; then it has been supposed that there is a gradual accumulation in living bodies of matters which overcome the vital force by their chemical affinities; this we cannot allow, because then also the vital force must be always diminishing from the first, and so far from any accumulation, we know there is constant waste and throwing off of particles unfit for life. Dr. Gregory says on this subject, "nature effects her object by a gradual process of hardening the materials and vessels of the human frame,—the finest vessels of the circulation lose

their pliancy, the muscles stiffen, the nerves lose their sensibility; the arteries most affected by this process are those of the brain, which become so brittle as to be the frequent cause of apoplexy; the lungs also suffer in their structure in a similar manner, producing inflammation of the lining membrane and death from being rendered impermeable to the air; paralysis, dropsy, disease of the heart are all aided by this process in old age. But comparatively few persons die of natural decay; it has been computed that about 400 per 1000 die at an advanced age, but of these only 175 drop from natural decay, others generally dying from acute diseases: of the remaining 600, death occurs prematurely either in infancy, youth, or maturity, especially, by consumption, the deaths by which are 170 per 1000; the proportion may be stated in lower numbers, as, by consumption rather more than 1 out of 6, and 1 to old age, and its consequences, *i. e.* to premature decay, and 1 to natural decay, the remainder by acute diseases and accidents."

The precise time of cessation of life and mind is difficult to determine; sometimes there is no mental manifestation for a period previous to death—sometimes the mind retains its vigour to the last; we cannot pronounce when "*mind*" may be said to leave the body, or whether it departs with the ordinary signs of life; these points seem beyond our knowledge; but with regard to "*life*," certain properties which belong only to living bodies do remain after what we call death has taken place, as though the loss of life, or its destruction or suspension, were

gradual. *Irritability*, as it is called, remains for some time; it is this property which is necessary for the muscular movements caused by galvanism and other irritants applied after apparent death; it is retained longer by cold blooded animals and those lowest in the scale, and would appear to be similar to the irritability of plants mentioned at pp. 13—18 *ante*. It is very remarkable that the movements of the small hair-like organs, called "cilia," found on the surface of membranes, continue even longer than the irritability of the muscles, and even when cut from the body completely.—(For further account of these, see *Appendix.)* *Decomposition* and rigidity of the limbs do not occur until a certain time has elapsed; and the particles of dead organic matter, as we call it, are for a certain period *capable of affording nourishment* to living bodies; *i. e.* they may themselves be again assimilated to a living structure, a process which inorganic particles cannot undergo. But this property is soon lost.

After all that we have said upon life, mind, and organism, it will be seen that we have not succeeded in explaining these phenomena, we have only explained how they are connected, and the conditions necessary for their operation. We must confess ourselves unable to offer from science any reason why life should exist or why death should occur; there certainly appears no reason why an object once endowed with life should not live for ever, for the state of maturity might be prolonged for ever as it is; there is nothing impossible in such a state: or such a perfected condition might arise at once and continue

for ever. If we could imagine a physiologist seeing for the first time an organic structure, such as the human frame, in a state of perfection, however closely he might examine it and however intimately he might know the structure, he could not, without the knowledge of experience, pretend to say there appeared any reason why death should occur; he would not indeed conceive such a thought as death.

APPENDIX.

THERE are some subjects referred to in the preceding pages which could hardly be sufficiently dealt with in their place without breaking the thread, therefore the following explanatory remarks, though not given in any particular order, may prove acceptable.

Organic matter.

The simplest form of organic matter is that of solution, such as the serum of blood, and part of the lymph and chyle, probably this simple form is endowed with vitality: but these fluids contain globules or minute molecules, which some have thought constituted the structure of the body, because various structures are said to be made up of "molecules aggregated in the form of fibres, lamellæ, and membranes;" this however is not admitted: it appears, nevertheless, that molecules in the form of cells are the simplest form of animal structure we have yet discovered, and all the tissues are developed from such forms: we have already had occasion to refer to the simple form of a perfect plant as a simple cell, and a perfect animal also in the same condition, (infusory animalcule) still further, we find the germ of the highest animals also a cell: in some lower animals, the embryo resulting from the early changes in the geminal cell is seen to be formed of granules. According to Schleiden, cells are formed upon minute molecules or granules formed of still minuter nucleoli, by the deposition of a film upon them; these cells become transformed in various ways in shape and texture, forming all the complicated organs of the body; "the heart of the embryo beats while yet a mass of cells, united to all appearance by amorphous matter in which no fibres are seen, yet no

one would doubt that its motions depend then on the same property as at a later period, when its structure is fully developed." *(Sharpey in Quain's Anat.)* Certain parts of the perfect animal body are composed partly of cells; as the ganglionic globules of the brain and nerves; the epithelium and epidermis, delicate insensible and in organised membranes, are also composed of nucleated cells, (Figs. 10, 11, 12,) with or without little hair-like bodies on them, which possess a remarkable power of moving; even the pigment which covers the inside of the eye, and that which forms the colouring matter of the negro skin, is found to be formed of hexagonal cells containing the colouring matter in form of very minute granules. These examples of parts of the living body of such a simple nature, yet possessed of vital properties, as proved in the motions of their cilia, suggest the thought that the highest animals do not differ from plants so much in the real nature of their elementary structure as in the complexity of their arrangement and the greater dependance of parts on the whole; the function which can be performed by the perfected whole is another question. Some of the lowest animals are possessed of cilia as the means of moving about, or for carrying on their simple form of nutrition; the ova of some plants also possess the same organs of locomotion, *(Unger;)* the ciliated cells of epithelium "are endowed with the power of producing motion, and possess whatever organic apparatus and whatever physical or vital property may be necessary for that end; single cells are seen to exhibit the phenomenon long after they have been completely insulated." *(Sharpey in Quain's Anat.)* These little bodies are constantly wearing from off the surface of the body and that of the mucous membranes; perhaps this led Dr. Grant to suggest that the human body is an aggregation of animalcules which are constantly being shed, as it were, in an effête state.

The movements of the vegeto animalcules of the ulothrix, Fig. 9. and their transformation into parts of the plant, are very wonderful, and form a very curious link between the animal and vegetable kingdom; those of the animalcules enclosed in the antheridia, Fig. 14, are equally mysterious.

With regard to the ciliary and such-like movements, Dr. Sharpey seems to think they may be attributed to "vital contractility," but at present no certain explanation can be offered.

Movements of animals not caused by the will.

We have spoken of movements of the voluntary muscles which occur without the action of the will and even after death: of these are laughing caused by tickling, sneezing by irritating the membrane of the nose as in taking snuff, winking the eyes when an object touches the eyelashes, coughing from irritation of the throat, the effect produced on the breathing by sudden sprinkling with cold water, and others: the beautiful action of the iris or coloured part of the eye in shading the sensitive portion of the organ is dependant upon an action of this kind, if a brilliant light be allowed to fall upon the eye, the pupil contracts, or more properly speaking, the iris spreads out and narrows the opening through which the light passes to the retina; the light does not act upon the iris, for if a small ray of light only be made to pass through the opening of the pupil, without touching the iris, the action takes place. Decapitated animals, more especially reptiles, exhibit these movements for a long time after death; small pieces even of snakes and lizards move from the same action; the tail of a newt will even swim in water as if it were alive, if it is scratched; a horse just felled by the pole-axe is made to wink the eye, if the nostril is tickled or scratched, though the creature is essentially dead.

The act of swallowing is in a great measure produced by this sort of action; the morsel of food acts as the irritant to the nerves of the throat and gullet, the muscles contract upon it and it is swallowed; so admirable is the provision for supporting life by food when the power of the will may be quite exhausted.

Dr. Quain relates a case of a female child which lived five months healthy and strong till within twelve days of death, in which no brain existed, a little bulb only being found, though the spinal cord was entire. From these cases it will be seen that many important functions, which are governed by the will, may also be produced by stimulants from without, applied to the sentient extremities of the nerves; but the spinal cord is requisite for their occurrence, and it is considered to be the medium through which they are produced.

Movements after death.

The most astonishing of these is that of the heart; this organ continues to move with considerable force for some time

after death in the higher animals, and the regular beating is not stopped if it be cut out altogether; in the lower animals it retains this property for a much longer time. It is thought that this is dependant on the nerves which it contains; for if opium is placed on the inside of the organ, the rythmic movements soon cease, and if the spinal cord and brain are suddenly destroyed, the action ceases as suddenly. This is another remarkable instance of the tenacity with which important organs retain their vital function. The waving movements of the little hair-like bodies upon the surface of membranes continues for some time after death, and even upon pieces cut out from the body. In a fresh-water tortoise it continued for fifteen days, in parts separated from the animal and placed in water; it is not destroyed by poisons nor by heated water of 180° applied for a moment. (*Purkinje* and *Valentin.*)

Duration of life without food or air.

It appears that simple animals can dispense with these stimuli for a long time. "Mollusca and insects, as well as the scorpion, have been kept for months without food. Serpents and tortoises also live for months without food, while man in the healthy state can scarcely survive a week. Several insects will live for days in mephitic gases; the larvæ of the œstrus, for example, according to the experiments of Van der Kolk, live for a long period in irrespirable gases. Molluscous animals have been kept during 24 hours under the air-pump. Reptiles live a very long time without respiring; in water deprived of its air some few hours, according to Spalanzani and Edwards, and in water still containing air, from 10 to 20 hours: frogs, the lungs of which I had extirpated, lived 30 hours. The numerous accounts, however, of toads, &c. having been found living in blocks of marble, and in trees, are to be regarded as instances of deception and credulity, although Herissaut and Edwards kept reptiles alive for some little time enclosed in gypsum. But Edwards is convinced that gypsum is permeable to atmospheric air; when the reptiles were surrounded both by gypsum and mercury, they died as quickly as if under water. The greater complication of the organization increases the state of dependance of the organs on each other. Simple animals therefore live longer after injuries, than animals higher in the scale.

Revival from the state of apparent death is much more easy in the lower animals." *(Müller.)*

Electricity in animals.

Many physiologists consider the phenomena of life to be dependant upon electricity, Hunter and Abernethy especially. Meissner supposes that, "during the chemical process of respiration, the blood becomes charged with electricity; that at the same time the electric fluid is distributed through the pulmonary nerves and the ganglionic system, and from them is communicated to the great nervous centres. He supposes further, that the brain, the seat of volition, being thus charged with electricity, excites the action of any desired organ by giving an electric spark to the corresponding nerve; that the electric fluid sent to the muscles forms an atmosphere around each of the molecules, which by their union in a linear form constitute a fibre, and thus forces asunder at their middle the muscular fibres, which being firmly united at their extremities, contraction of the muscle is produced, just in the same way as, when several threads, with a number of pith balls strung upon them, are tied together at both ends, hung upon an electric conductor and electrified, the individual balls and threads are forced asunder, and the two ends of all the threads are approximated." *(Müller.)*—Dr. Philip endeavoured to prove that digestion was carried on by means of electricity supplied by the nerves to the stomach. Another experimenter *(Weinhom)* declares, that having quickly destroyed the brain and cord of a cat, and supplied their place with an electric amalgam, the creature suddenly sprang up and ran from the table. Humboldt discovered that a frog's leg contracts if its nerve and muscles are touched at the same time by a muscle: Buntzen formed a pile of alternate layers of muscle and nerve: Prevost and Dumas found that a piece of muscle connected with a saline solution or blood, by platinum conductors, affected the galvanometer: Kaemtz constructed dry piles of concentrated solutions of organic substances, spread on thin paper.

Very curious electric phenomena are seen in frogs at the spring time of year. Müller discovered that if the nerve of the leg be made to touch the skin covering the muscles of the limb, the muscles contract both at the moment of contact and sepa-

ration. Whether this electricity is the result of the vital condition or merely produced by the contact of different substances is uncertain. The production of movements in the muscles, by mere contact of the nerve, is very remarkable, and would lead us to suppose that currents of electricity existed in the nerves and the body generally. Pouillet thought he had detected electric currents in the needles inserted in the flesh in acupuncture, but this has not been verified. Vavasseur and Beraudi have asserted that needles, inserted in the nerves of a living animal, become magnetic, so as to attract iron filings. M. David says, that when a wire was inserted in a nerve of a living animal, electricity was shown at the moment the animal moved; but these observations have not been confirmed, and Müller finds that the frog's leg, which is the most delicate electrometer, is not influenced at all by contact with a nerve subjected to irritation.

It must be remembered, that all these effects upon muscles, and even secretion of gastric juice, may be produced by simple mechanical irritation of the nerves. Whether the nerves conduct any principle analogous to electricity or light, or whether they act by conducting, something like the vibrations of solid continuous bodies produced by any mechanical impression, is at present questionable; the fact of the perfect distinctness of each filament of a nerve, from its origin at the brain to its end at the skin or other sensitive surface, and that when divided all influence ceases until the cut ends are united, certainly favours the view of conduction of some kind.

It has been ascertained that a low degree of electricity is produced in man in a healthy state; that excitable persons have more free electricity than phlegmatic persons; that the quantity is greater in the evening than in the day, and greater after the use of spirituous drinks. Women are more often *negatively* electric than men, who are generally *positive*. *(Pfaff and Ahrens.)*

Production of heat in animals.

The temperature of the body is maintained at about 100°; this varies slightly in mammalia, being 95° in the porpoise. In birds it is higher than in man. Young animals and old ones have not the same power of producing heat as those in maturity; very young animals require to be constantly close to the mother,

or their temperature falls so much as to destroy life. Some animals will resist the temperature of the polar regions (50° below zero) without becoming torpid, and others become torpid or hybernate at a few degrees above zero. Hybernation seems to be entirely dependant on temperature, as marmots have been put to sleep in summer by being placed in an ice-house. The embryo possesses no independent heat, but derives it from the mother; the heat developed subsequently and kept up in after life is dependant on the respiration, organic processes, such as secretion and nutrition, and the nervous influence.

Production of new animals by shoots.

This process bears a perfect analogy to the growth of plants by buds; the bud of a plant contains the elements of a more complicated condition, and, as is well known, if placed in a position to receive nourishment, continues to grow and unfold itself, although separated from its parent stem. But the leaves of some, which are more simple than buds, will grow, if planted; indeed, it is proved that all the parts of plants are leaves variously metamorphosed; even the stem alone is capable of growing and producing fresh shoots or individual parts. In the polype, Fig. 1, Plate II, we have the stem and branches, a common cavity running through both; each shoot if separated becomes a new creature, but the whole animal is impelled by one will. If a polype without branches, corresponding to the naked stem of a plant, be cut in any direction, or pieces cut out, the portions so made become perfect creatures, with a digestive cavity and arms. Trembley found that the parts of two different polypes would unite, if kept in apposition, and form a perfect animal which produced sprouts. Portions of the arms do not produce shoots, it is necessary that some part of the body should be taken; so it appears that reproductive power is possessed by portions of an animal which have no especial form and properties as germs have, but consist of various parts of an aggregate. In plants all the tissues are produced from cells; the increase of filiform fungi, such as that of yeast, Fig. 7, Plate II, is begun from a single cell, from which another cell sprouts, and when this has acquired its full size, it also gives out a little protuberance; if these cells are separated, they still produce fresh cells. *(Cagniard.)*

In the fungus, penicillum glaucum, Fig. 6, Plate II, an advanced state is seen; the tubular structure becomes divided into cells at the apex, which become the spores, and separate to become new individuals. In higher plants and animals new individuals are produced from special cells, which contain the germinal cell, (see Fig. 8, 8A, B, Plate II,) and these require the influence of fecundation before they begin to alter and grow into new individuals.

Opinions of the ancient philosophers.

Sensation.—Apollodorus says, ὡς δια βακτηριας τυ ταθέντος ἀέρος τὸ βλεπόμενον ἀναγγέλλεται, which Cudworth translates, "the sense taking cognizance of the object by the interposed medium that is tense and stretched (thrusting every way from it upon the optic nerves) doth by that, as it were by a staff, touch it."

Aristotle says that Democritus and others of the atomological philosophers, make all sense to be touch, and resolve sensible qualities into the figures of insensible parts or atoms.

Plato, of the senses, says, "you must conceive that which is called a white or black colour not to be any thing absolutely existing either without or within your eyes; but black and white, and every other colour, is caused by different motions made upon the eye from objects differently modified;" so that it is nothing either in the agent nor the patient absolutely, but something which arises from between them both. "Can you or any other man be confident that every colour appears to him just as it does to every man and animal, any more than tastes and touches, heat and cold do?" He concludes with "ὐδὲν εἶναι αὐτὸ καθ' αὐτό, ἀλλὰ τινὶ αἰεὶ γίγνεσθαι."

Memory.—Aristotle thought that children do not remember well on account of the softness of their brains, and old men on account of the hardness and rigidity of their brain; supposing that the too great softness prevented the retention of impressions, and the hardness their production; although this notion is crude enough, yet it agrees tolerably with what we meet with as the result of softening or hardening of the brain, the memory being very generally affected.

Lud. Dolce, in his dialogues upon this subject, makes his pupil say, in reference to his theory of the situation of the faculties,

"Benissimo io cio veggio; et ogni cosa posta e collocata al suo luogo," and explains, saying, "E, perche questa parte è piu humida di quello, che fa bisogno, onde mal conserva le ricevute spetie."

Life.—Aristotle speaks of seeds as life, εν ἐυναμει, corresponding precisely to Müller's "potentiality."

Mind.—The distinctions I have endeavoured to make out between mind, intellect, and soul, at p. 112, seem to have been admitted by the ancient philosophers; they distinguished between the spirit and the soul, calling the former sometimes νους or πνευμα: the latter, ψυχη. St. Paul confirms this in speaking of πνευμα, ψυχη, and σωμα.

Specific Weight of Brain.—At p. 193, in speaking of the weights of brains, it was suggested that observations on the density of brains would be useful: in Quetelet's work it is said, M. M. Leuret and Mitivié have commenced such observations in insane cases, and have determined the average as 1.031 water at 15°, being unity.

Duration of Life.—The mean durability of life has increased of late years, partly in consequence of increased medical skill, partly from improvements in drainage, ventilation, and cleanliness. In the time of the Romans the average was 25 years. The Geneva Tables show, in 1750 to 1800, the average to be 34½; in 1832, 45 years 29 days; at Paris it is, amongst the better classes, 42 years; in England, 50 years; so that the number of years a child may be expected to attain now is double what it was at the commencement of the christian era.—*(Finlayson.)*

Insanity and Idiotcy.—Although not subscribing to all the deductions M. Quetelet wishes to support, in his work on Man, there is much which, as the result of statistical observation, is worthy of notice; he considers that with regard to age, mental alienation may be divided into *imbecility* in infancy, *mania* in youth, *melancholy* in mature age, and *madness* in advanced age.

"It is between the 30th and 50th years that the imagination and reason are most productive, and by a singular contrast, it is also about the same age that mental alienation is most frequent, and the cure most difficult. The intellectual life of man and the diseases of the mind especially develop themselves about the age of 25 years, when physical development has almost ceased: man,

indeed, at this age, is almost entirely developed, and it is at this time that the greatest tendency to crime is manifested."

Esquirol says that insanity is in direct proportion to civilization. Idiotcy is a state depending on soil and material influences, whilst insanity is the product of society and of moral and intellectual influences.

Idiots.—" In general we observe that in mountainous countries there are many more idiots than in level ones; and in plains where agriculture is pursued, we find more idiots than in towns; in France and New York the number of idiots is very small; in Norway, one-third of the deranged; in Scotland, one-half; Wales, one-half; England, about one-eighth.

Proportion of Insane Persons to Population.

	Population.	
Norway	1 in 551	
England	1 in 783	
Wales	1 in 911	
Scotland	1 in 573	
New York	1 in 721	
France.....	1 in 1000"	*(Quetelet.)*

Chemical theory of Life.—From the fact that none of the vital processes either commence or proceed without chemical decomposition and presence of atmospheric air with a certain amount of heat, it has been argued that life was entirely dependant upon such chemical changes, that all its phenomena are chemical, and that life is nothing more than a chemical condition: it is true that certain kinds of mould, which is a minute and simple plant, are not produced if the substance on which it is formed be covered with oil or varnish, but still the ova or germs of this plant may be there and only quiescent, because the changes to which the air conduces are prevented. The condition of life in the germ to which we have often alluded remains unexplained; however, it is asserted by several observers, that mould and even insects have been produced in closely stoppered vessels, more especially with the aid of currents of electricity, but these are viewed with great suspicion.

There is little doubt that latent heat or that which forms a part of substances, influences both the form and qualities of

those substances; the effect of latent or combined heat in the living body may be very important, because we know that a certain amount of heat is indispensable both for setting up and continuing life, and that a constant supply of heat is produced by the various vital processes of the living system, the nerves especially, which we have seen are actuated upon some principle of conduction being necessary for this heat.

In connection with these matters, it is curious that many seeds are provided with an oil as part of their structure. Now the specific (combined) heat of oil is very great; that of water being 1000, oil of turpentine is 426, nearly double that of any other substance not gaseous, and it requires a heat of 320° to boil oils. When an oil is exposed to a very low temperature, it does not become wholly solid; a considerable portion remains fluid, and fluids contain more specific heat than solids, so that the seed is protected perhaps by this means. Water, we have seen, is necessary to living bodies; now it is also remarkable that the specific heat of water is far greater than that of any other liquid or solid, and in the form of vapour it is still greater, being, as compared with that of air as unity, 1.9600. The form in which water exists in the animal and vegetable tissues may be allied to that of vapour, it is certainly not that of its ordinary liquidity. Then it must be remembered, that the ocean is an inexhaustible store of this necessary fluid. The necessity of heat and water to the form and production of crystals, and the influence of electric currents upon the process, as well as the peculiar condition of water in them, called "water of crystalization," which cannot be lost without destruction of the form, are also matters which must not be lost sight of, and are as inexplicable as the phenomena of life.

J. Dennett, Printer, 121, Fleet Street.

ERRATA.

Page 21, line 28, *C. Nutrition* should be *c. Nutrition.*
.. 23, .. 28, *D. Reparation* .... *d. Reparation.*
.. 24, .. 27, *E. Generation* .... *e. Generation.*
.. 32, .. 13, for *Distona* read *Distoma.*
.. 36, .. 14, .. *particles* .. *parietes.*